Contracting Branch - Infrastructure Division
4200 Smith School Road
Austin, Texas 78744

INVITATION FOR BIDS AND CONTRACT DOCUMENTS
FOR
GARNER STATE PARK, UVALDE COUNTY, TEXAS
Project No. 117504
WATER TREATMENT PLANT IMPROVEMENTS – PACKAGE 2
BID SET
TECHNICAL SPECIFICATIONS
APRIL 2019

STATE OF TEXAS
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# TEXAS PARKS AND WILDLIFE DEPARTMENT

**GARNER STATE PARK**

**WATER TREATMENT PLANT IMPROVEMENTS**

**PACKAGE 2**

TPWD Project No. 117504

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SECTION 01 10 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work covered by these contract documents titled “Garner State Park Water Treatment Plant Improvements – Package 2” comprises the construction of improvements at Garner State Park Water Treatment Plant and is included as Bid Option or Alternate Bid Item to another project titled “Garner State Park Well and Water Line – Package 1”. Drawings and specifications are specific to the work included in each package. Some of the work identified as “existing” facilities or as work “by others” may be included as proposed work in “Garner State Park Well and Water Line – Package 1.” It is the Contractor’s responsibility to coordinate the work in both Package 1 and Package 2.

B. This section describes the project in general and provides an overview of the extent of the Work to be performed. Detailed requirements and extent of Work is stated in the applicable Specification Sections and shown on the Drawings. The Contractor shall, except as otherwise specifically stated herein or in any applicable parts of these Contract Documents, provide and pay for all labor, materials, equipment, tools, construction equipment and other facilities and services necessary for proper execution, testing, successful start-up and completion of the Work.

C. Any part or item of the Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable shall be performed by the Contractor and the expense thereof shall be included in the bid price. It is the intent of these Specifications to provide the Owner with complete operable systems. All miscellaneous appurtenances and other items or work that are incidental in meeting the intent of these Specifications shall be considered as having been included in the bid price, even though these items may not be specifically identified in the Specifications.

D. The Work shall include all civil, structural, mechanical, electrical, and instrumentation work for complete and operable systems.

1.02 PROJECT IDENTIFICATION AND CONTACT INFORMATION

A. Project Identification: Garner State Park Water Treatment Plant Improvements, Package 2

B. Project Location: 234 RR 1050, Concan, Texas 78838.

1.03 DESCRIPTION OF WORK

A. The scope of the work to be completed is defined by the Drawings and the Specifications. In general terms the Work consists of furnishing all labor, supervision, materials, equipment, tools, transportation, and related items as required to construct, complete, start-up, test, and place in service the following improvements:

1. New Sodium Hypochlorite Facility
   a. Installation of one new prefabricated fiberglass chemical building.
b. Installation of two liquid sodium hypochlorite metering pumps, located in the new Sodium Hypochlorite Building.

c. Installation of all related piping and tubing, valves, controls, and appurtenances.

2. New Hydro-Pneumatic Tank

a. Demolition of existing 6,000-gallon hydro-pneumatic tank and related supports and appurtenances.

b. Installation of a new 1,000-gallon hydro-pneumatic tank, with supports, and tank-mounted air charging system.

c. Installation of all related piping and tubing, valves, controls, and appurtenances.

d. Commissioning of the new hydro-pneumatic tank.

3. Replacement of Interior Coatings at Existing Tanks

a. Abrasive blast interior of existing 5,000-gallon hydro-pneumatic tank and coat with NSF-61 approved coating.

b. Abrasive blast interior of existing 100,000-gallon ground storage tank and coat with NSF-61 approved coating. Replace water level indicator.

4. Construction of new gravel drive at Water Treatment Plant area.

1.04 WORK RESTRICTIONS

A. On-Site Work Hours: Work shall be generally performed on-site during normal business hours between 7:00am to 6:00pm, Monday through Friday, except as otherwise indicated in the Uniform General Conditions (UGCs).

B. Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner.

1. Contractor shall submit a shutdown plan to the Owner’s designated Project Representative for acceptance within 21 days of Notice to Proceed. Thereafter, the Contractor shall update the shutdown plan at a minimum on a monthly basis for more frequently if requested by the Project Representative.

2. Utility Outages and Shutdown: Provide a minimum of 1-week notice to the Owner and private utility companies (when applicable), excluding weekends and holidays, in advance of required utility shutdown. Coordinate all work as required.

C. Several parts of the proposed Work under this Contract will connect with or into existing facilities. Work which requires a shutdown of existing equipment shall be coordinated with the Owner in writing. Work which requires a shutdown and or interruption of an existing treatment process and resulting plant flow shall be submitted to the Owner, in writing a minimum of 21 days prior to the shutdown.

1.05 ENVIRONMENTAL CONTROLS

A. The Contractor shall furnish labor, materials, equipment and incidentals necessary to provide storm water pollution prevention for the duration of the construction period in accordance with
including furnishing, installing and maintaining erosion and sediment control structures and
procedures and properly removing the features when no longer needed.

1.06 PERMITS

A. Owner has or will obtain approval for construction from the following agencies:
   1. Texas Commission on Environmental Quality (TCEQ).
   2. Texas Department of Licensing and Regulation (TDLR).

B. The Contractor shall obtain any required Storm Water Pollution Prevention Permits (SWPPP) from the TCEQ. Contractor shall implement best management practices for control of storm water on all areas of the Project Site.

C. Contractor shall obtain any other permits required to complete the work not specifically listed herein.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION
SECTION 01 12 16
CONSTRUCTION SEQUENCE

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. The construction of this project will occur while the existing Garner State Park Water Treatment Plant is operating to meet specific, critical water demand and permit requirements. The operations necessary to meet these requirements are of higher priority than construction activities. Schedules of connections, renovations and modifications shall be submitted to the Owner in writing for approval, and all such items shall be coordinated throughout the entire construction period. These schedules shall permit full and normal treatment of water.

B. The Contractor shall prepare and submit a Shutdown Schedule within 21 days of notice to proceed, outlining the schedule and time requirements for each item involving an existing treatment unit, piece of equipment, and conveyance system.

C. The Contractor shall notify the Owner in writing at least 21 days in advance and again 3 days prior to beginning work on a particular area, and coordinate with the Owner the specific items to be isolated and duration for each. Contractor shall obtain written approval from the Owner prior to each shutdown. High flow demand conditions or treatment equipment outages may require the rescheduling of an approved shutdown.

D. Work requiring interruptions to the raw water entering the existing water treatment plant shall be coordinated with the Owner and scheduled by the Contractor for periods of not more than 4 hours and during off-peak flow hours. All shutdowns shall be limited in duration.

E. The Contractor shall not operate any valves, gates, or equipment in the plant unless directed to do so by the Owner. The Contractor shall schedule all valve or gate closures with the Owner. Existing valves and gates may not seal completely or properly. Contractor shall provide any temporary containment and/or pumping, at no additional cost to the Owner, to perform the Work.

F. Prior to beginning work, the Contractor shall have on-site all materials, equipment, and personnel necessary to complete the work in the time scheduled. The Contractor shall also perform all possible tasks to the most complete state possible prior to shutdowns. All exposed bolts and nuts on valves or fittings that are to be disassembled shall be removed and replaced one at a time prior to shutdown to assure timely progress.

G. Failure of the Contractor to properly plan and perform the Work in the prescribed manner may result in distribution of inadequately treated water. In this case, the Contractor may be liable for payment of fines, fees or other charges imposed upon the Texas Parks and Wildlife Department by state or federal regulatory agencies, and all other costs associated with the inadequately treated water.

H. Existing plugged pipelines, in which water has been standing, may have to be cleaned of debris prior to connecting to a new pipeline or installing protective coatings and linings.
1.02 CONSTRUCTION SEQUENCE

A. In addition to the Substantial Completion and Final Acceptance dates, critical beneficial use milestones have been assigned to the Project to ensure that the flow of work is progressing in a timely manner.

B. The following sequence is for information only and is intended to represent a general sequence of construction of major activities in which the Work can proceed. The sample sequence provided below is not intended to represent a complete shutdown and/or work plan. Although the Contractor is not obligated to follow the sample sequence as set forth below, his plan shall conform to the construction constraints specified herein. All shutdowns or flow diversions must be conducted by the Owner.

C. Constraints

1. The existing water treatment plant must be kept in operation at all times. Contractor shall provide all temporary provisions in order to keep the facilities in service.

2. Existing water treatment plant must remain in-service at all times. Contractor shall coordinate connections to existing system with the Owner prior to performing work, as specified herein.

3. One hydropneumatic tank must be in service at all times. Contractor may not remove the existing 5,000-gallon hydropneumatic tank for recoating unless the new 1,000-gallon hydropneumatics tank is installed, tested, and in service.

4. One sodium hypochlorite system must be in service at all times. Contractor may not demolish the existing sodium hypochlorite system until the new sodium hypochlorite is in installed, tested, and in service.

D. Connections to the Existing System

1. Temporary shutdowns may be required to make connections to existing system. Connections to the existing system require advance notification and concurrence from the Owner prior to isolating or shutting down process units.

2. All disinfection and testing of piping to be connected to existing plant piping and disinfection of tanks shall be completed and test reports furnished to the Engineer prior to making connections.

3. Contractor to provide all taps, flushing, blow-off connections or other materials needed to flush and disinfect each pipe section.

4. Reduce the number of shutdowns required for piping connections by combining as many connections at the same time as feasible.

5. Time allowed for shutting down the process and dewatering the existing pipe is in addition to the actual connection time. The Contractor shall provide all equipment tools and labor to dewater the pipes for connections. This process water shall be contained in the facilities and not allowed to discharge to the ground or to surface drainage systems. The time period allowed for these connections will not exceed four (4) hours total unless approved in writing by the Owner.
E. Construction Activities
   1. The Contractor shall perform the work of construction activities to accommodate normal plant operations with only minimal process interruptions necessary for process unit isolation, piping and electrical connections. The Contractor will provide written request for all process interruptions to the Owner per Contract Documents.

   2. Install a new sodium hypochlorite building and chemical feed system. Connect to existing injection points. Demolish existing sodium hypochlorite feed system.

   3. Demolish existing 6,000-gallon hydropneumatic tank and supports, and install a new 1,000-gallon hydropneumatic tank, including supports and tank-mounted air compressor.

   4. Abrasive-blast and recoat the interior of existing 5,000-gallon hydropneumatic tank.

   5. Abrasive-blast and recoat the interior of existing 100,000-gallon steel ground storage tank.

   6. Disinfect and test all piping prior to connections to the existing system. Piping connections include, but are not limited to:
      a. Connection of new sodium hypochlorite feed to existing injection points as shown on the Drawings.
      b. Connection of new hydropneumatics tank inlet/outlet to existing 4-inch treated water line as shown on the Drawings.

   7. Construct site improvements.

F. Construction Activities Requiring Temporary Provisions
   1. The existing water treatment plant must be kept in operation at all times. Contractor shall provide all temporary provisions in order to keep the facilities in service.

G. Construction Activities Requiring Coordinated Shut Downs
   1. Tie-Ins to Existing System
      a. Temporary shutdowns may be required to make connections to existing system. Contractor shall coordinate any required shutdowns prior to performing work as specified herein.

H. Refer to General and Supplementary Conditions for Startup Procedures.

PART 2 PRODUCTS - NOT APPLICABLE
PART 3 EXECUTION - NOT APPLICABLE

END OF SECTION
SECTION 01 18 00

PROJECT UTILITY SOURCES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install necessary materials and make arrangements for the connection of utilities for the project. The required utilities are electrical services.

1.02 REFERENCE STANDARDS

A. Comply with all service installation standards of the serving utility companies.

PART 2 PRODUCTS

2.01 ELECTRICAL SERVICE

B. The Contractor shall coordinate with the electric utility company for installation of work as shown on the Drawings. Access to the site must be coordinated with the Owner. Provide materials and equipment required to connect the project service to the system. Coordinate with the electric utility company for requirements of power service. All connection costs to be paid by the Owner.

PART 3 EXECUTION

3.01 UTILITY

A. There are currently 4 (four) utility poles at the site. The existing poles have low vertical clearance. Coordinate with the electric utility company to raise the vertical clearance as required to allow truck clearance under the lines.

B. A new 1-phase, 240VAC system is proposed for the Water Treatment Plant. The Contractor shall provide a service pole, meter and 100A fused disconnect per the electric utility company’s requirement for service.

C. Contractor to add new conduits on the load side of the transformer as shown on the Contract Drawings to accommodate the new loads.

D. Contractor to follow the mechanical work and construction sequencing specified in Section 01 10 00 – Summary of Work and Section 01 12 16 – Construction Sequencing. Electrical equipment shall be energized on time.

E. Contractor to minimize interruption of service. Contractor to coordinate with Owner prior to any interruption of service per Section 01 10 00 – Summary of Work.

F. All fees required by the electric utility company will be paid directly to the electric utility company by the Owner.

G. Contractor to provide 480V main circuit breakers, switchboard, MCCs, as well as all necessary cabling as shown on the contract drawings.
H. Contractor is to provide and install all low voltage (120V, 208V, 480V, etc.) distribution equipment and hardware associated with the project as shown on the Drawings.

END OF SECTION
SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities. The Section also includes provisions for the project sign, plant operation during construction and plant shut downs, and other related work.

B. Related Sections:
   1. Division 1 Section 01 10 00 - Summary of Work and Section 01 12 16 - Construction Sequence for limitations on utility interruptions and other work restrictions.
   2. General and Supplementary Conditions - Submittals for procedures for submitting copies of implementation and termination schedule and utility reports.

1.03 DEFINITIONS

A. Permanent Enclosure: As determined by the Engineer, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

1.04 USE CHARGES (REFER TO THE UGC)

1.05 SUBMITTALS

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

1.06 QUALITY ASSURANCE

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

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

C. Comply with applicable requirements specified in other sections of Specifications and General and Supplementary Conditions of the Contract.
   1. Maintain and operate temporary facilities and systems to assure continuous service.
   2. Modify and extend systems as the Work progress requires.
   3. Completely remove temporary materials and equipment when no longer required.
   4. Restore existing facilities used for temporary services to specified or original condition.
1.07 PROJECT CONDITIONS

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

B. Progress Cleaning: Clean Project site and work areas daily, including common areas, in accordance with the General and Supplementary Conditions of the Contract.

PART 2 PRODUCTS

2.01 MATERIALS


2.02 EQUIPMENT

A. Fire Protection:
1. Furnish and maintain onsite adequate firefighting equipment capable of extinguishing incipient fires. UL rated; with class and extinguishing agent as required by locations and classes of fire exposures. Comply with applicable parts of National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).
2. Provide portable fire extinguishers, rated 2A minimum, at Contractor's and Engineer’s field office, and at storage sheds.
3. Ensure that internal combustion engine powered equipment is located a safe distance from combustible materials.
4. Prohibit smoking in locations and operations of potential fire hazard and clearly post "No Smoking" or "Open Flame" signs.

B. Flammable Material Storage: Store flammable/combustible liquids in conformance with requirements of federal and local codes and regulations, and prohibit storage of flammable/combustible liquids near exits, stairways or common passageways. Provide approved metal safety containers for storage of flammable/combustible liquids in excess of 1 gallon.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

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

3.02 TEMPORARY UTILITY INSTALLATION

3.03 PLANT OPERATIONS DURING CONSTRUCTION AND PLANT SHUTDOWNS

A. The following stipulations shall apply to the construction on this project.
1. The ability of the plant to meet permit requirements is critical and will take priority in allowing shutdown of existing facilities. All shutdowns of any plant facilities must be coordinated with the Engineer and the Owner. The Contractor shall request permission from the Engineer to take existing equipment, structures, roadways, pipelines and electrical and instrumentation facilities out of service at least thirty (30) days prior to the requested date.

2. The request must include the proposed date; the proposed time for initiating the shutdown; the proposed time for returning the item back to service; a description of the item to be taken out of service; the purpose of the shutdown; and any other information which may be needed by the Engineer to evaluate the request.

3. This request must be repeated twenty-one (21) days and again one (1) week prior to the requested date. The Contractor shall not initiate the shutdown until approval is granted. The Owner reserves the right to choose a range of times during the day or night that work associated with shutdowns must be completed in order to protect plant operations.

4. The Contractor is reminded that this is an operating plant and that, as such, it must remain in service during the construction period with no degradation in performance.

5. Contaminated or turbid water cannot be pumped into the streets or storm drainage system or any stream. The Contractor must obtain the Owner's approval for his proposed method to discharge into the plant's system. Process facilities must be accessible to plant personnel at all times. For these reasons, although approval for a shutdown may be granted, operating conditions at the plant may require that the shutdown be canceled at the last minute, or that the time allowed for the shutdown be reduced. No additional compensation will be made to the Contractor for these unforeseen changes in the schedule.

6. If failure of the Contractor to properly plan and prosecute the work results in the discharge of untreated or partially treated water, the Contractor will be liable for payment of such fines as may be imposed on the Owner by applicable state or federal regulatory agencies, and any and all other costs which result from these fines.

3.04 SUPPORT FACILITIES

A. Storage Sheds: Provide storage sheds for products in conformance with the General Conditions.

B. Equipment and Material Storage: Properly store and protect equipment to be delivered to the job site until installation in accordance with manufacturer's recommendations. Properly store and protect existing equipment to be relocated until installation and conform with the General Conditions.

C. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations and access to field offices and shall conform to the General Conditions. When possible, locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.

2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 00 00 - Earthwork.

3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.

4. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
D. Traffic Controls: Comply with requirements of authorities having jurisdiction and conform with the General Conditions.
   1. Protect existing site improvements to remain including curbs, pavement, and utilities.
   2. Maintain access for fire-fighting equipment and access to fire hydrants.
   3. Construction traffic shall be controlled to minimize impact of normal plant traffic.
   4. Contractor shall repair damage to plant and public roadways.
   5. Provide signs warning of a construction site entrance.
   6. Provide flagman when excessive construction traffic is expected.

E. Parking: Provide temporary parking areas for construction personnel. Do not park under trees.

F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction and conform with the General Conditions. Maintain Project site, excavations, and construction free of water.
   1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
      a. Remove snow and ice as required to minimize accumulations.

G. Project Identification and Temporary Signs: Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
   1. Provide temporary, directional signs for construction personnel and visitors.
   2. Maintain and touchup signs so they are legible at all times.

H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.

3.05 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Conform with the Uniform General Conditions.

3.06 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. Where excavation or demolition endangers adjacent structures (including fences) and utilities, the Contractor shall at his own expense carefully support and protect all such structures and/or utilities to prevent failure or settlement. Where it is necessary to move services, poles, guy wires, pipelines or other obstructions, the Contractor shall notify and cooperate with the utility owner.

B. In case damage to an existing structure or utility occurs, whether failure or settlement, the Contractor shall restore the structure or utility to its original condition and position without compensation from the Owner. The Contractor shall protect any plant equipment in construction areas, which remain in service during construction.

C. Contractor shall repair or replace all damaged street surfaces, driveways, sidewalks, curb and gutter, fences, drainage structures, or other structures, to the satisfaction of the Engineer and the Owner. Structures shall be restored to a condition equal to or better than the original condition and of a similar material and design. The costs of such repair or replacement shall be borne by the Contractor and shall be included in the Proposal.
D. The Plans show the locations of all known surface and subsurface structures and utilities. However, the Owner and the Engineer assume no responsibility for failure to show any or all of these structures or utilities on the Plans, or to show them in their exact locations. It is mutually agreed that such failure shall not be considered sufficient basis for claims for additional compensation for extra work or for increasing the pay quantities in any manner whatsoever, unless the obstruction encountered is such as to necessitate changes in the lines or grades, or require the building of special work, provisions for which are not made in the Plans and Proposal, in which case the provisions in these Specifications for extra work shall apply.

E. It is anticipated that some utilities exist which are not shown on the Plans. The Contractor, prior to ordering material and beginning work, shall make an independent survey to locate and identify the type and size of all existing piping and valves in the construction area, using hand excavation if necessary.

F. The Contractor shall keep an accurate record of the location, depth, size, type of material, and type of service of all underground utilities encountered during construction. All piping, valves, electrical conduits, etc., in the construction area shall be protected as necessary, in a manner acceptable to the Engineer. No additional compensation will be considered for the protection of any of these items whether shown on the Plans or not.

G. It is the sole responsibility of the Contractor to confirm the location of all subsurface piping, electrical conduits, etc., which affect the prosecution of his work prior to ordering materials or beginning work.

3.07 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor, except as noted elsewhere. Owner reserves right to take possession of Project identification signs.

2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in the General and Supplementary Conditions.

3.08 DUST CONTROL

A. The Contractor shall be responsible for eliminating and/or alleviating dust resulting from his construction operations. This is particularly applicable to dust which results from vehicular traffic traveling along or through areas where construction has resulted in dirt of dust being left on
roadways. The Contractor shall sprinkle water or use other dust control methods which will reduce dust to a minimum. The Owner may request additional dust control sprinkling at any time as deemed necessary. Dust control will be considered subsidiary to construction and no separate measurement and payment will be made.

END OF SECTION
SECTION 02 30 00

SUBSURFACE INVESTIGATION

PART 1 GENERAL

1.01 SCOPE OF WORK
   A. No soil investigations were accomplished on the site for use in the design of the proposed facilities.

PART 2 PRODUCTS

2.01 SOIL INVESTIGATION REPORTS
   A. The Contractor shall perform additional geotechnical investigation as he deems necessary for his construction activities. There shall not be any additional payment or extension of contract time to the Contractor for additional geotechnical investigations and resulting additional work that they may require to complete the project.

2.02 CONTRACTOR'S RESPONSIBILITY
   A. No available geotechnical report or boring logs are available prior to bidding. Contractor to make his own determinations as to all subsurface conditions.

PART 3 EXECUTION - NOT APPLICABLE

END OF SECTION
SECTION 02 41 13
SELECTIVE SITE DEMOLITION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Uniform General Conditions (UGC) and Special Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following selection demolition work when shown on the Drawings:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

B. Related Sections include the following:
   1. Refer to General Provisions of the Contract, including General and Supplementary Conditions and Division 1 for cutting and patching procedures.
   2. Division 31 Section 31 11 00 "Site Clearing and Grubbing" for site clearing and removal of above-and below-grade improvements.

1.03 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction and deliver them to Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.04 SUBMITTALS

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

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

C. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
1.05 QUALITY ASSURANCE

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

B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

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

D. Standards: Comply with ANSI A10.6 and NFPA 241.

E. Predemolition Conference: Conduct conference at Project site.

1.06 PROJECT CONDITIONS

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

B. OWNER will maintain conditions existing at time of inspection for bidding purpose as far as practical.
   1. Before selective demolition, OWNER will remove the following items:

C. Notify ENGINEER of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.
   1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify ENGINEER and OWNER. OWNER will remove hazardous materials under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.07 WARRANTY

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and capped.
B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

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

E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.
   1. Submit photographs of existing conditions before "Photographic Documentation."

F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Arrange to shut off indicated utilities with utility companies.
   2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.03 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Comply with requirements for access and protection specified in Division 1 Section 01 50 00 "Temporary Facilities and Controls."

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

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

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
   2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
   4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   5. Dispose of demolished items and materials promptly.

B. Removed and Salvaged Items that are to be returned to the OWNER:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to OWNER.
   4. Transport items to OWNER'S storage area designated by OWNER.
   5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
   4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by ENGINEER, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.05 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain OWNER'S property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off OWNER'S property and legally dispose them.
3.06 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION
SECTION 03 01 30

CONCRETE REPAIR AND MODIFICATIONS

PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to cut, remove, repair or otherwise modify parts of in-place concrete.

B. Work under this Section may also be performed as a remedy for improperly or poorly constructed concrete, or concrete damaged during construction operations. Such work shall be performed only after receiving written directions from the Engineer.

1.02  RELATED WORK

A. Division 03 - Concrete

B. Division 05 - Metals

1.03  REFERENCE STANDARDS


1. ASTM C78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)


3. ASTM C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).


8. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.


B. American Concrete Institute (ACI).

1. ACI 301: Specification for Structural Concrete

2. ACI 304: Guide for Measuring, Mixing, Transporting & Placing Concrete

3. ACI 304.2R: Placing Concrete by Pumping Methods
4. ACI 305R: Guide to Hot Weather Concreting
5. ACI 306R: Guide to Cold Weather Concreting
6. ACI 308: Guide to Curing Concrete
7. ACI 308.1: Specification for Curing Concrete
8. ACI 309: Guide for Consolidation of Concrete
10. ACI 350: Code Requirements for Environmental Engineering Concrete Structures

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions and the Contract Documents.

B. Submit a Schedule of Demolition which includes the extents and detailed methods of demolition to be used at each location.

C. Submit a Plan of Repair for any structure that requires repair which includes the extent of, and detailed methods of, repairs to be utilized.

D. Submit Manufacturer's technical literature on all product brands proposed for use. The submittal shall include the manufacturer's installation and/or application instructions.

E. When substitutions for acceptable brands of materials specified herein are proposed by the Contractor, submit Manufacturer's substitutions for approval prior to delivery to the Site. Submitted data shall demonstrate compliance with all requirements of this Specification or deviations shall be clearly noted.

1.05 QUALITY ASSURANCE

A. No existing structure or concrete shall be shifted, cut, removed, or otherwise altered until written authorization is given by the Engineer.

B. No proposed or existing structure shall be repaired or otherwise altered until written authorization is given by the Engineer. Notify the Engineer of any defects in the original construction and submit a proposed repair plan for review prior to performing any repair work.

C. When removing materials or portions of existing structures and when making openings in existing structures, all precautions shall be taken and all necessary barriers, shoring and bracing, and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work to protect personnel, to control dust, and to prevent damage to the structures or contents by falling or flying debris.

D. Manufacturer qualifications. The manufacturer of the specified products shall have a minimum of 5 years experience in the manufacture of such products, and shall have an ongoing program to provide training and technical support for the Contractor's personnel.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver the specified products in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Store products as recommended by the Manufacturer.
PART 2 PRODUCTS

2.01 GENERAL

A. Materials shall comply with these Specifications and any applicable federal, state or local regulations.

B. All materials used shall be approved for use in potable water facilities.

2.02 REPAIR CONCRETE

A. Use Class A concrete in accordance with Section 03 30 00 for large volume repairs unless otherwise directed.

2.03 REPAIR MORTAR

A. Repair mortar shall be a polymer modified prepackaged cementitious repair mortar.

B. Use an appropriate product for the specific application in accordance with all Manufacturer’s requirements and recommendations.

C. Material Properties.

1. Compressive strength (ASTM C109):
   a. 3800 psi min. at 7 days.
   b. 4800 psi min. at 28 days.

2. Splitting Tensile strength (ASTM C496):
   a. 500 psi min. at 28 days.

3. Flexural strength (ASTM C78):
   a. 1300 psi min. at 28 days.

4. Bond strength (ASTM C882 Modified):
   a. 2000 psi min. at 28 days.

5. Color to match surrounding material color which is exposed to view.

D. Products and Manufacturers:

1. SikaTop 121 Plus as manufactured by Sika Corporation.

2. SikaTop 122 Plus as manufactured by Sika Corporation.

3. SikaTop 123 Plus as manufactured by Sika Corporation.

4. EMACO R310 CI, as manufactured by BASF.

2.04 STRUCTURAL CRACK INJECTION

A. Concrete Sealing Epoxy

1. High strength moisture insensitive epoxy system in compliance with ASTM C881, Type IV, Grade 3, Class B & C and with the following properties:
   a. Tensile properties at 14 days (ASTM D638)
      (i) Tensile strength: 5,500 psi
      (ii) Minimum elongation: 2%
   b. Compressive properties at 28 days (ASTM D695)
(i) Compressive strength: 10,000 psi
(ii) Modulus of elasticity: 300,000 psi
c. Flexural strength: 12,000 psi at 14 days (ASTM D790)
d. Compressive strength: 14,000 psi (ASTM D695)
e. Bond strength: 2,200 psi after 2 days (ASTM C882)
f. Maximum water absorption of 0.1 percent after 24 hours

2. The color of the sealing epoxy shall match the existing color of surrounding concrete surfaces if exposed to view.

3. Products and Manufacturers
   a. Sikadur 31 as manufactured by Sika Corporation.

B. Epoxy Injection Resin
   1. High modulus, low viscosity epoxy crack injection system in compliance with ASTM C881, Type IV, Grade 1, Class B&C and with the following properties:
      a. Tensile properties at 14 days (ASTM D638)
         (i) Tensile strength: 5,500 psi
         (ii) Minimum elongation: 2%
      b. Compressive properties at 28 days (ASTM D695)
         (i) Compressive strength: 10,000 psi
         (ii) Modulus of elasticity: 300,000 psi
      c. Flexural strength: 12,000 psi (ASTM D790)
      d. Bond strength: 2,800 psi after 2 days (ASTM C882)
      e. Maximum water absorption of 0.15 percent after 24 hours

2. Products and Manufacturers
   a. Sikadur 35 as manufactured by Sika Corporation.

2.05 WATERPROOFING INJECTION

A. Concrete Expansion Joint and Active Crack Sealing
   1. SikaFix HH Hydrophilic as manufactured by Sika Corporation.
   2. SikaFix HH LV as manufactured by Sika Corporation.

B. Water Infiltration Under Pressure
   1. SikaFix HH+ as manufactured by Sika Corporation.

2.06 WATER PRESSURE LEAKAGE AND SEEPAGE WATERSTOP

A. Fast Setting Portland Cement Based Waterstop
   1. Material Properties
      a. Compressive Strength (ASTM C109):
         (i) 4200 psi min. at 7 days.
         (ii) 6800 psi min. at 28 days.
      b. Tensile Strength (ASTM C496):
         (i) 600 psi min. at 7 days.
         (ii) 700 psi min. at 28 days.
c. Setting Time (ASTM C266)
   (i) Initial set of approximately 90 seconds.
d. Color
   (i) Concrete gray.

2. Products and Manufacturers
   a. SikaSet Plug as manufactured by Sika Corporation.

PART 3 EXECUTION

3.01 GENERAL

A. Apply methods specified in this Section as indicated on the Drawings, as specified, or as directed and/or approved by the Engineer. Finishes, joints, reinforcements, sealants, etc., shall be as specified in their respective Sections of the Specifications.

B. All commercial products specified in this Section shall be mixed and applied in strict compliance with the Manufacturer's recommendations.

C. In all cases where concrete is repaired in the vicinity of an expansion joint or isolation joint, the repairs shall be made to preserve the isolation between components on either side of the joint.

D. When drilling holes in concrete for dowels or bolts, drilling shall stop if reinforcing steel is encountered. The hole shall be relocated to avoid reinforcing and the existing hole patched with repair mortar per this Section. Reinforcing shall not be cut. Where possible, reinforcing locations shall be identified prior to drilling using non-destructive methods such as "rebar locators", GPR, etc. so that drilled hole locations may be adjusted to avoid reinforcing interference prior to drilling.

3.02 CONCRETE REMOVAL

A. General
   1. Concrete specified to be left in place which is damaged by the Contractor shall be repaired by approved means to the satisfaction of the Engineer at no cost.

B. Concrete Removal Equipment
   1. Use sawing equipment capable of sawing concrete to the specified depth.
   2. Use power driven chipping tools no heavier than a 30 lb. class for bulk concrete removal and no heavier than a 15 lb. class for removal of concrete beneath reinforcing steel or along the edges of the repair area.
   3. Hydrodemolition equipment may be used with prior written approval of the Engineer or via an approved Schedule of Demolition.

C. Concrete Removal Procedures and Requirements
   1. Concrete removal shall be initiated by first saw cutting to a depth of 1 inch (or by line drilling if saw cutting is not feasible) at the given removal limits. Remove concrete to the required depth by chipping or jack-hammering, as appropriate, in areas where concrete is to be taken out. Use the smallest equipment possible to avoid bruising or damaging concrete outside the removal zone and in accordance with this Section. Remove concrete in such a manner that surrounding concrete, existing reinforcing to be left in place and existing in place equipment are not damaged.
2. All existing reinforcing exposed during concrete removal that will be covered with new material shall be undercut, exposing the entire perimeter of the bar, a minimum of 1 inch or 1.5 times the maximum aggregate size of the repair material, whichever is greater. Reinforcing to be left in place shall not be damaged during demolition.

3. Where existing reinforcing is exposed due to saw cutting or core drilling and no new material is to be placed on the cut surface, a coating or surface treatment of epoxy paste shall be applied to the entire cut surface to a thickness of 1/4 inch. Reinforcing shall be drilled and ground to establish minimum cover requirements prior to application of the surface treatment.

3.03 REPAIR PREPARATION

A. Surface Preparation
   1. Where bonding to existing surfaces, clean and remove all deteriorated materials, dirt, oil, grease, and all other bond inhibiting materials from the surface by abrasive blasting, grinding, etc. as approved by the Engineer. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete.

   2. Where bonding new concrete to existing concrete, the existing surface shall be roughened to a minimum 1/4 inch amplitude or greater if a larger amplitude is required by the repair material manufacturer.

B. Existing Reinforcing Steel
   1. Existing reinforcing which is exposed shall be cleaned by mechanical means to remove all loose material and corrosion products before proceeding with the repair.

3.04 REPAIR EXECUTION

A. Install any required formwork in accordance with Section 03 10 00.

B. Prior to installing the repair concrete, or mortar, clean the concrete surface and apply mortar or epoxy bonding agents as required for Construction Joints in accordance with Section 03 15 00. Apply a hydrophilic waterstop per Section 03 15 00 for water retaining structures or if called for in Drawings.

C. Install repair concrete, mortar or other repair material in accordance with all manufacturer’s instructions and Section 03 30 00. In the event of a conflict between the manufacturer’s instructions and Section 03 30 00, the more restrictive requirement shall apply.

D. Cure the repair in accordance with all manufacturer’s instructions and Section 03 30 00. In the event of a conflict between the manufacturer’s instructions and Section 03 30 00, the more restrictive requirement shall apply.

3.05 EPOXY CRACK INJECTION

A. Flush out cracks and voids with chemical agent or chemical solvent to remove dirt and laitance prior to epoxy injection.

B. Provide temporary entry ports spaced to accomplish movement of fluids between ports, complying with Manufacturer's recommendations. Provide seal at concrete surface to prevent epoxy leakage.
C. Inject epoxy into prepared ports under appropriate pressure, using equipment appropriate for the particular application. Begin injection at lowest entry port and continue until adhesive appears at adjacent entry port; continue from port to port until each crack is filled.

D. After epoxy adhesive has fully cured, remove temporary seal and excess adhesive. Grind surfaces smooth.

END OF SECTION
SECTION 03 10 00

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This section defines requirements for design, construction, erection and removal of concrete formwork.

1.02 RELATED WORK

A. Coordinate the requirements of this section with all other Sections and Contract Documents.

1.03 REFERENCE STANDARDS

A. American Concrete Institute (ACI).
   2. ACI 301: Specifications for Structural Concrete.
   3. ACI 347: Guide to Formwork for Concrete.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with all the requirements of the General Conditions and Contract Documents.

B. Submit manufacturer’s literature, data and installation instructions for all proprietary materials, manufactured form systems, ties and accessories.

C. Submit proposed method of sealing form tie holes; coordinate with details shown.

D. If shoring and reshoring of concrete structural members is required, submit a shoring-reshoring operational plan(s) signed and sealed by a Professional Engineer licensed in the state where the project is located.

1.05 STORAGE AND HANDLING OF MATERIALS

A. Store materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective waterproof covering, providing for adequate ventilation. Store materials in accordance with all manufacturer’s recommendations.

B. Form lumber shall be delivered to the job site as far in advance of its use as is practical, and shall be carefully stacked clear of the ground in such a manner as to facilitate air-drying.

C. Handle materials to prevent damage in accordance with the manufacturer’s recommendations.

1.06 QUALITY ASSURANCE

A. Design Criteria for Formwork, Falsework and Shoring-Reshoring
1. The design and engineering of all concrete formwork, including all shoring, reshoring, bracing and reshoring, shall be the sole responsibility of the Contractor and shall be performed by a Professional Engineer licensed in the state where the project is located.

2. Design for loads, lateral pressure, and allowable stresses as described in ACI 347. Design for all lateral loads and other applicable requirements of controlling local building codes.

3. Camber formwork to compensate for anticipated deflection during placement of concrete when required to maintain specified tolerances.

4. Design formwork to be readily removed without impact, shock, or damage to concrete surfaces and adjacent materials.

5. Design for fresh concrete as the pressure exerted by a liquid weighing 150 pounds per cubic foot. Additionally, the rate of concrete placement, concrete temperature and all other pertinent factors shall be taken into account.

6. Design for all construction loads imposed during construction.

7. Forms shall have adequate stiffness to maintain mortar-tightness and true final dimensions of member being constructed within specified construction tolerances.

8. Falsework and shoring shall be designed to provide required strength and stiffness to insure safety and that no excessive settlement or deformation occurs.

9. Falsework and shoring shall be supported on an adequate foundation to provide required strength and stiffness to support the superimposed load without settlement.

B. Alignment Control & Allowable Tolerances

1. Construct and erect formwork in accordance with ACI 117, ACI 301 and ACI 347.

2. True alignment of walls and other vertical surfaces having straight lines shall be controlled and checked. Forming shall be arranged with provisions for adjusting the horizontal alignment after the form has been filled with concrete. Establish a transit line or other reference so that adjustments can be made to an established line while the concrete is still plastic.

PART 2 PRODUCTS

2.01 MATERIALS

A. Lumber & Plywood

1. Properly seasoned and of good quality; free from loose or unsound knots, holes, shakes, splits, decay and other imperfections that would affect its strength or adversely affect the finished concrete surface.

B. Form Linings

1. Fiberboard: Hardwood finished smooth on one side with minimum thickness of 3/16 inch.

2. Plywood: Conforming to APA HDO; exterior exposure waterproof adhesive with minimum thickness of 3/8 inch.

C. Form Release Agent:

1. A ready to use water based material formulated to eliminate or reduce surface imperfections free of kerosene, mineral oils, waxes or resins.
2. Release agent shall not discolor or injuriously affect the finished concrete surface, subsequent coatings or concrete curing.

D. Coating for Plastic Forms
   1. Alkali-resistant gel-coat.

2.02 FABRICATIONS

A. Forms
   1. General
      a. Chamfers: Provide a chamfer on all exposed edges by using either wooden or plastic chamfer strips. Chamfer strips shall be a forty-five degree right triangle in section with the two shorter sides measuring 3/4-inch.
      b. Waterproofed Surfaces: At surfaces to be waterproofed, provide formwork with sufficient anchor pattern to facilitate bond of the membrane waterproofing.

   2. Smooth Forms:
      a. Construct formwork with plywood; tempered, concrete-form hardboard; dressed lumber faced with plywood or fiberboard lining; metal; plastic; or metal-framed plywood-faced panel material acceptable to the Engineer to provide continuous, straight smooth surfaces. Form material will be free of raised grain, torn surfaces, worn edges, patches, dents or other defects. Furnish material in largest practical sizes to minimize the number of joints and, when shown on the drawings, conform to the joint system shown. Form material will have sufficient strength and thickness to withstand the pressure of newly placed concrete without bow or deflection.
      b. Smooth forms will be used on all concrete surfaces exposed to view or liquid in the completed structure.

   3. Rough Forms:
      a. Construct forms of dressed or undressed lumber free of knots, splits, or other defects; plywood; metal; or other material acceptable to the Engineer. Material shall have sufficient strength and thickness to withstand the pressure of newly placed concrete without bow or deflection.
      b. Rough forms may be used on concrete surfaces that will not be exposed to view or liquid in the completed structure.

B. Void/Carton Forms.
   1. Use new carton forms of corrugated cardboard. Forms shall be impregnated throughout with paraffin and laminated with water resistant adhesive. Do not use trapezoidal carton forms.
   2. Forms of the height indicated on the drawings shall be designed to support the wet concrete plus normal construction loads.
   3. Soil retainers shall be composed of materials that are not adversely affected by moisture and as directed in the Drawings.
   4. Carton forms provided around the perimeter of drilled shafts shall be installed using pre-manufactured sealed void forms with curved edges.
   5. Install carton forms according to the manufacturer’s recommendation and maintain in a dry condition prior to concrete placement. Carton forms that have not been maintained in a dry condition shall be replaced before concrete is placed.
6. Acceptable Manufacturers:
   a. VoidForm Products
   b. Sayway Carton Forms
   c. Voidco Fiberboard Void Forms

C. Metal Forms
   1. All specified requirements for “Forms” regarding design, mortar tightness, geometry, bevels, chamfers, bracing, alignment, removal, re-use, oiling, etc. shall apply equally to metal forms.
   2. Metal used for forms shall have adequate thickness to remain true to shape. Clamps, pins and other connecting devices shall be designed to hold the forms rigidly together and allow form removal without injury to the concrete.
   3. Bolt and rivet heads on exposed surfaces shall be countersunk.
   4. Metal forms that do not present a smooth surface free from rust, grease or other foreign materials that discolor concrete shall not be used.

D. Slip Forming
   1. Slip forming is not permitted.

2.03 FORM ACCESSORIES

A. Form Ties
   1. Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders.
   2. Ties of a type intended to be entirely removed shall be coated with an acceptable lubricant to safeguard against damaging the concrete during such removal. The use of wire ties will not be permitted.
   3. Use removable cones of one-inch by one-inch minimum size on the end of the form tie.
   4. Grout depressions left in concrete by the cones with non-shrink grout after the ends of the cones have been removed.

B. Form Sealer
   1. Surface sealer that will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces when applied to most forms or form liners. A ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations.

PART 3 EXECUTION

3.01 FORM CONSTRUCTION

A. General
   1. All formwork, scaffolds and work platforms shall be safe and conform to OSHA Requirements.
2. Construct and maintain formwork, complying with ACI 347 and this Section so that it will maintain correct sizes of members, shape, alignment, elevation and position during concrete placement and until concrete has gained sufficient strength. Provide for openings, offsets, sinkages, keyways, recesses, moldings, anchorages and inserts, as required.

3. Construct forms for easy removal without damage to concrete surfaces.

4. Formwork shall be sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

5. Chamfer strips shall be placed in forms to bevel all edges and corners permanently exposed to view, except the top edges of walls and slabs which are shown to be tooled. Edges of formed joints and interior corners shall not be beveled unless shown or specified otherwise. Equipment bases shall have formed beveled edges for all vertical and horizontal corners. Unless otherwise noted, bevels shall be 3/4-inch wide.

6. Form ties shall be employed in such places and at such intervals as to securely hold the forms in position during the placing of concrete, and to withstand the weight and pressure of the wet concrete.

7. Provide temporary openings at the base of column and wall forms and at other points as required to facilitate observation and cleaning immediately before concrete is placed. Temporary opening shall be 2' x 2' in size or as required by Owner’s Representative.

8. If runways are required for moving equipment, provide for support of runways with struts or legs resting directly on the formwork or structural member. Do not allow runways or supports to rest on reinforcing steel.

9. Provide openings below large pipe (over 10" diameter) or large embedments to allow adequate concrete fill and minimize honeycombs and voids.

10. Construct forms with such care as to produce concrete surfaces which will not have unsightly or objectionable form marks in exposed concrete surfaces. Forms shall have all contact surfaces thoroughly cleaned before reuse.

B. Forms for Surfaces Exposed to View or Liquids:

1. Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Form ties shall be uniformly spaced and aligned in rows.

2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.

3. Form molding shapes, recesses and projections with smooth-finish materials and install in forms with sealed joints to prevent displacement.

4. Form exposed corners of beams and columns to produce square, smooth, solid, unbroken lines. Provide all exterior exposed corners with 3/4-inch chamfer.

5. Arrange facing material in an orderly and symmetrical fashion. Keep the number of seams to a practical minimum. Support facing material adequately to prevent deflection in excess of allowable tolerances.

6. For flush surfaces exposed to view in the completed structure, overlap previously placed hardened concrete with form sheathing by approximately 1-inch. Hold forms against hardened concrete to maintain true surfaces, preventing offsets or loss of mortar.
C. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finish slab surface. Provide and secure units to support types of screeds required.

D. Surface to Receive Membrane Waterproofing: Provide chamfers for external corners in concrete surfaces that will be covered with membrane waterproofing. Provide a continuous reglet at line of top of membrane waterproofing on vertical surfaces. Coordinate location with waterproofing applicators.

3.02 TOLERANCES

A. Construct formwork so that concrete surfaces will conform to tolerance limits as listed in ACI 117, ACI 301 and ACI 347.

B. Establish sufficient control points and bench marks as references for tolerance checks. Maintain these references in undisturbed condition until final completion and acceptance of the project.

3.03 ADJUSTMENTS OF FORMWORK

A. Use wedges or jacks to provide positive adjustment of shores and struts. Wedges used for final adjustment of forms should be fastened in position after final inspection and before concrete placement.

B. Securely brace forms against lateral deflections. Prepare to compensate for settling during concrete placement.

C. For wall openings, construct wood forms that facilitate any necessary loosening to counteract swelling of forms.

3.04 PREPARATION OF FORM SURFACES

A. Before placing concrete, clean surfaces of forms and embedded materials. Remove accumulated mortar, grout, rust and other foreign matter.

B. Coat forms for exposed or painted concrete surfaces with form oil or form-release agent before placing reinforcement. Cover form surfaces with coating material used in strict accordance with the Manufacturer's printed instructions. Do not allow excess coating material to accumulate in forms or to contact hardened concrete against which fresh concrete will be placed. Remove coating material from reinforcement before placing concrete.

C. Other than retained-in-place metal forms, forms for unexposed surfaces may be wet with water immediately before concrete placement in lieu of coating. One exception is that when a possibility of freezing temperatures exists, use of a coating is mandatory.

3.05 REMOVAL OF FORMS

A. Forms shall not be removed until the concrete has adequately hardened and set. Clamps or tie rods may be loosened twenty-four (24) hours after the concrete is placed; ties, except for a sufficient number to hold the forms in place, may be removed at that time.

B. Forms on vertical surfaces, when repair of surface defects or finishing is required before concrete is aged, may be removed as soon as concrete has hardened sufficiently to resist damage from removal operations.
C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed provided that concrete has hardened sufficiently to resist damage from removal operations and provided the removal of these forms will not disturb members supporting the weight of the concrete.

D. All forms and shoring used to support weight of concrete or any construction loads shall remain in place until concrete has reached the minimum strength specified for removal of forms and shoring as specified in item 3.06 of this Section. In no case shall forms be removed in less than 4 days.

E. If removal of formwork occurs before required curing is complete, exposed concrete surfaces shall be cured immediately after the removal of formwork until all curing requirements are met. See Section 03 30 00 for curing requirements.

3.06 REMOVAL STRENGTH

A. Specified Removal Strength
   1. The minimum concrete compressive strengths for removal of all formwork supporting the weight of concrete shall be 100 percent of the specified minimum 28 day strength of the class of concrete involved.

B. Control Tests: Suitable strength control tests will be used as evidence that concrete has attained the removal strength required for removal of formwork or shoring supporting the weight of concrete in structural members or construction loads.
   1. Field-Cured Test Cylinders. When field-cured test cylinders reach the specified removal strength, formwork or shoring may be removed from the respective concrete placements. Strength data from field-cured test cylinders shall be furnished by the Contractor.
   2. Laboratory-Cured Test Cylinders. When concrete has been cured as specified for cast-in-place concrete for the same time period required by laboratory-cured cylinders to reach the specified removal strength, the formwork or shoring may be removed from respective concrete placements. Determine the length of time that the concrete placement has been cured by totaling the number of days or fraction of days, not necessarily consecutive, during which the air temperature surrounding the concrete is above 70 degrees F and the concrete has been damp or thoroughly sealed against evaporation and loss of moisture.

3.07 SHORING AND RESHORING

A. When reshoring is permitted or required, plan operations in advance and secure approval of such operations from the Engineer. All shoring and reshoring shall be designed by a Professional Engineer retained by the Contractor who is licensed in the State in which the project is constructed.

B. Shoring and Reshoring shall comply with ACI 301, ACI 347 and ACI 347.2R.

C. While reshoring is under way, keep live load and construction loads off the new construction. Do not permit concrete beams, slab, column or other structural member to be subjected to combined dead and construction loads in excess of loads permitted for developed concrete strength at the time of reshoring.
D. Place reshores as soon as practicable after stripping operations are complete but in no case later than the end of the working day on which stripping occurs. Tighten reshores to carry the required loads without overstressing construction. Leave reshores in place until tests representative of concrete being supported have reached specified strength.

E. Floors supporting shores under newly placed concrete shall have their original supporting shores left in place or shall be reshored. The reshores shall be located directly under a shore position above unless other locations are permitted. Extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

3.08 FORM REUSE

A. Do not reuse forms that are worn or damaged beyond repair. Thoroughly clean and recoat forms before reuse. For wood and plywood forms to be used for exposed smooth finish, sand or otherwise dress concrete contact surface to original condition or provide form liner facing material. For metal forms, straighten, remove dents and clean to return to original condition.

END OF SECTION
SECTION 03 15 00

CONCRETE JOINTS AND EMBEDDED ITEMS

PART I GENERAL

1.01 SCOPE OF WORK

A. This section specifies requirements for all concrete joints and embedded items for all cast-in-place concrete.

1.02 RELATED WORK

A. Division 03 – Concrete
B. Division 05 – Metals
C. Coordinate work of this section with all other sections to obtain a proper installation. Review all drawings and specifications for additional requirements for joints and embedded items.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM):


B. American Concrete Institute (ACI)

1. ACI 301 – Specifications for Structural Concrete.

2. ACI 503.2 – Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive.

C. U.S. Army Corps of Engineers (CRD)

1. CRD-C572 – Corps of Engineers Specifications for Polyvinyl Chloride Waterstops.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions and the Contract Documents.

B. Shop Drawings.

1. Submit shop drawings showing all concrete joints, proposed sequences for concrete placement and type of concrete specified. Concrete may not be placed without a joint layout and pour sequence reviewed by the Engineer.

C. Product Data.

1. Submit manufacturer's technical literature on all products proposed for review. The submittal shall include the manufacturer's installation and/or application instruction.

2. When substitutions are proposed for acceptable brands of materials specified herein, submit brochures and samples of proposed substitutions to the Engineer for approval before delivery to the project.
1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for joints in concrete shall be stored and covered to prevent contact with the ground and to avoid contact with weather and direct sunlight. Follow all additional requirements of the manufacturer.

PART 2 PRODUCTS

2.01 CONCRETE EXPANSION JOINTS (GENERAL)

A. Expansion Joint Sealant

1. Single or multi-component cold-applied polyurethane elastomeric joint sealant conforming to ASTM C920. Sealant must be appropriate for the specific application. Provide joint primer according to Manufacturer's recommendation.

2. Material Properties
   d. Tear strength (ASTM D624): 50 lb./in., min.
   e. Adhesion in peel (concrete): 10 lb./in., min.
   g. Color: gray.

3. Water Immersion & Chemical Resistance
   a. If joint will be immersed in water or exposed to wastewater, or chemicals, sealant must exhibit good resistance to water immersion and good chemical resistance

B. Expansion Joint Filler

1. Resilient non-bituminous material conforming to ASTM D1752. Material must be compatible with the joint sealant.

C. Joint Accessories

1. Backer Rod
   a. Extruded closed-cell polyethylene foam rod compatible with the joint sealant. Rod shall be 25% larger than the joint opening.

2. Bond Breaker Tape
   a. Polyethylene or TFE-fluorocarbon self adhesive tape, compatible with the joint sealant.

2.02 CONCRETE EXPANSION JOINTS (EXTERIOR ROADWAY & PAVEMENTS ONLY)

A. Expansion Joint Sealant

1. Hot-poured elastic joint sealant conforming to ASTM D6690. Sealant must be appropriate for concrete pavement. Provide joint primer according to Manufacturer's recommendation.

B. Expansion Joint Filler

1. Preformed bituminous type conforming to ASTM D994. Material must be compatible with the joint sealant.
2.03 CONCRETE BONDING AGENT
A. Concrete Exposed to Water and/or Chemicals
   1. ASTM C881, Type IV. Grade and Class shall be as required for the project application. A
      field service representative of the Manufacturer shall be available during initial application
      to instruct the Contractor in the proper use of the product when so requested by the
      Engineer or the Owner.
B. Concrete Not Exposed to Water or Chemicals
   1. Acrylic bonding agent conforming to ASTM C1059.

2.04 BOND BREAKER
A. 30-pound asphalt saturated felt or polyethylene membrane.

2.05 EXPANSION JOINT DOWELS
A. Smooth steel bars shall conform to the requirements of Section 03 20 00. Cut dowels to length
   at shop or mill before delivery to the site. Dowels must be straight and clean, free of loose flaky
   rust and loose scale.

2.06 EXPANSION JOINT DOWEL SLEEVES
A. Metal or plastic dowel sleeve. Sleeve shall be sized to allow dowel to move complete width of
   joint without binding.

2.07 WATERSTOPS
A. General
   1. All waterstop materials shall be compatible with potable water applications per AWWA
      and any other industry standards.
   2. Unless otherwise called for in the Drawings or specified herein, provide PVC waterstops
      where waterstops are indicated in the Drawings.
B. Polyvinyl Chloride Waterstops (PVC)
   1. Material Requirements
      a. Waterstops shall be extruded from virgin polyvinyl chloride compound and shall
         conform to the requirements of the Corps of Engineers Specification CRD-C572. Waterstops
         shall be uniform in dimension, homogenous and free from porosity. No
         reclaimed or scrap material may be used.
      b. Tensile strength: 1400 psi minimum.
      c. Ultimate Elongation: 280 percent minimum.
   2. Construction Joints
      a. Ribbed type without center bulb.
      b. 6 inch minimum width.
      c. 3/8 inch minimum thickness.
   3. Expansion Joints
      a. Dumbbell type with a mimum 3/4-inch inside diameter center bulb.
      b. 9 inch minimum width.
c. 3/8 inch minimum thickness.

C. Thermoplastic Elastomeric Rubber (TPE-R)
   1. Where joints will be exposed to harsh chemical environments and where indicated in the Drawings, provide TPE-R waterstops in lieu of PVC waterstops.
   2. Material Requirements
      a. Waterstops shall be a fully vulcanized blend of EPDM and polypropylene (thermoplastic vulcanize). Waterstops shall be uniform in dimension, homogenous and free from porosity. No reclaimed or scrap material may be used.
      c. Ultimate Elongation: 450 percent minimum.
   3. Construction Joints
      a. Ribbed type without center bulb.
      b. 6 inch minimum width.
      c. 3/8 inch minimum thickness.
   4. Expansion Joints
      a. Dumbbell type with a minimum 3/4-inch inside diameter center bulb.
      b. 9 inch minimum width.
      c. 3/8 inch minimum thickness.

D. Hydrophilic Waterstops
   1. Hydrophilic waterstop materials shall be bentonite-free and expand by a minimum of 80% of dry volume in the presence of water to form a water-tight joint without damaging the concrete in which it is cast.
   2. The material shall absorb water and cause an increase in volume in a completely reversible and repeatable process. The material shall be dimensionally stable after repeated wet-dry cycles with no deterioration in swelling potential.
   3. Minimum cross sectional dimensions are 3/16 inch by 3/4 inch.
   4. Provide only where specifically indicated in the Project Documents.

E. Hydrophilic Sealants
   1. Hydrophilic sealant shall be compatible with hydrophilic waterstop and shall firmly adhere to concrete, metal and PVC in a dry or damp condition. When cured, it shall be elastic indefinitely.

F. Hydrophilic Injection Resin
   1. Hydrophilic injection resin shall be acrylate-ester based with a viscosity of less than 50 cps. The resin shall be water soluble in its uncured state, solvent free and non-water reactive. In its cured state it shall form a solid hydrophilic flexible material resistant to permanent water pressure and compatible with bitumen, joint sealants and concrete.

2.08 EPOXY ANCHORS

A. Refer to Section 05 05 00.

B. If Section 05 05 00 is not in the Project Documents, provide the following:
1. Provide stainless steel adhesive anchors and hardware complying with ASTM F593, AISI Type 316 headed with stainless steel nuts and washers.

2. Adhesive system shall Hilti HIT-HY200 adhesive, by Hilti. No substitutions will be considered.

3. Embedment depth of the anchor shall provide pullout strength equal to the allowable tensile capacity of the anchor, unless otherwise noted in the Drawings. Reduction in pullout strength due to spacing and edge distances shall be made.

2.09 MISCELLANEOUS EMBEDDED METAL ITEMS

A. Miscellaneous embedded metal items shall conform to the requirements Section 05 05 00 or the section of the specifications to which they apply. In the case of conflicting requirements, the most restrictive requirements shall apply.

B. Use “Form Saver” or “Threaded Coupler” to avoid drilling holes in the forms.

C. Paint aluminum contact surfaces with a zinc rich primer where aluminum items are embedded in concrete.

PART 3 EXECUTION

3.01 CONSTRUCTION JOINTS

A. General

1. Make construction joints only at locations shown and required on the Contract Drawings, the reviewed shop drawings or as directed or approved by the Engineer. Any additional construction joints or relocation of construction joints shown on the drawings that are proposed by the Contractor must be submitted to the Engineer for review.

2. Allow a minimum of three (3) days to elapse before placing concrete adjacent to a slab or wall previously placed.

3. All joints shall be perpendicular to main reinforcement; continue all reinforcing across the joint.

4. Provide waterstops in all wall and slab construction joints as specified or in all water bearing structures, all below grade joints and at locations shown on the Drawings.

B. Additional Construction Joints

1. In addition to construction joints explicitly shown in the Drawings, provide and locate additional construction joints as follows:

2. Walls.
   a. Locate vertical construction joints at a maximum spacing of 40 feet.

3. Foundation slabs and slabs-on-grade
   a. Locate construction joints at a spacing of 50 feet maximum. Place concrete in a strip pattern, unless otherwise indicated in the Contract Drawings, to a maximum of 2500 square feet in any one placement.

4. Structural slabs and beams
   a. Locate construction joints at a maximum spacing of 50 feet. Locate construction joints in compliance with ACI 301, unless otherwise indicated in the drawings, to a
maximum of 2500 square feet in any one placement.

C. Construction Joint Preparation

1. The joint surface of the previously cast member or existing concrete in all cases shall be cleaned free of all oil, grease, curing compound, dirt, or laitance, and shall be wetted. Cleaning shall be accomplished by high pressure water jet, wet sand blasting, dry sand blasting, or scrubbing, singly or in combination, as required and shall remove loosened particles of aggregate, damaged concrete at surface, and other substances which may prevent complete adhesion. Remove accumulated concrete on projecting reinforcing steel.

2. Construction joints shall be roughened mechanically to a full amplitude of ¼ inch. Thoroughly clean joint surfaces as described in this Section. Coat joints with neat cement slurry with the consistency of a heavy paste and scrub into surfaces by means of a stiff bristled brush. Place new concrete before cement paste dries. As an alternative to using a neat cement slurry, a bonding agent may be utilized.

3.02 EXPANSION JOINTS

A. Do not extend reinforcement or other embedded metal items that are continuously bonded to concrete through any expansion joints.

B. Position dowels accurately if called for in the Drawings. Support dowels against displacement during concrete placement and vibration. Install dowel sleeve grout-tight to prevent bonding of the dowel during concrete placement.

C. Position expansion joint filler material accurately. Support against displacement during concrete placement and vibration. Place filler the full depth of the member less an allowance to form a groove for sealant as detailed.

3.03 CONTROL JOINTS

A. Control joints shall be provided in non-water bearing slabs-on-grade only as called for in the Drawings and specified herein.

B. Make top grooves for control joints in slabs on grade as detailed and seal as specified. Grooves may be made with joint forming strip, via tooling or may be sawed.

C. If control joints are sawed, properly time cutting with concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking and within twelve (12) hours of concrete placement. The Contractor shall have at least one spare saw available during the sawing operation.

D. Control joints shall be cleaned and filled with expansion joint sealant. Inject sealant through a nozzle into the bottom of the joint, filling the entire joint space without air voids.

3.04 WATERSTOPS

A. General

1. Provide waterstops in all horizontal and vertical joints in foundation slabs and peripheral walls of all structures up to a minimum of 12 inches above final ground level and all walls and slabs of liquid-containing structures or compartments to a minimum of 12 inches above maximum liquid level unless specifically shown otherwise on the Drawings.
2. Provide PVC waterstops unless TPE-R waterstops are called for in the Drawings.

B. PVC and TPE-R Waterstops
   1. Each piece of pre-molded waterstop must be of maximum practicable length for a minimal number of end joints.
   2. All waterstops shall be continuous, and so jointed as to form a complete barrier to the passage of water through any construction, control/contraction or expansion joint.
   3. Joints in waterstops shall be made by heat sealing or other method approved by the Manufacturer in accordance with the requirements of the Manufacturer. The joints in strips of waterstop shall be such that the entire cross section of the joint shall be dense, homogeneous and free of all porosity. All finished joints shall have a tensile strength of not less than 75% of the material of the strip as extruded.
   4. Where waterstop is continuous in orthogonal directions, provide factory-made, pre-formed tee or cross waterstop pieces. Waterstop joints in the field shall only be butt-type joints.
   5. All waterstops shall be installed so that half its width will be embedded on each side of the joint. Tie the waterstop to the reinforcement at a maximum spacing of 18 inches to ensure that the waterstop will be held securely in true position and in straight alignment in the joint during placement and vibration of concrete.
   6. Care shall be exercised to ensure that the PVC waterstop is completely embedded in concrete and without voids.

C. Hydrophillic Waterstops
   1. Install hydrophilic waterstops as called for in the Drawings in accordance with the Manufacturer's requirements. Install hydrophilic sealant in accordance with all Manufacturer's requirements.
   2. The hydrophilic waterstop shall be installed in a bed of hydrophilic sealant compatible with the hydrophilic waterstop before skinning and curing begins so that any irregularities in the concrete surface are completely filled and the waterstop is bonded to the sealant. After the sealant has cured, secure the waterstop to the concrete in accordance with the Manufacturer’s instructions.
   3. Prior to installation of the hydrophilic sealant, clean the concrete surface to removed laitance and any other materials that will adversely affect bonding of the sealant to the concrete.

3.05 SEALING JOINTS

A. Clean, prime and apply sealants in accordance with Manufacturer's recommendations.

B. Sealant shall be applied when the ambient temperature is between 40° F and 90° F, unless recommended otherwise by the sealant Manufacturer.

C. During application, exercise care to prevent sealant from spilling onto surfaces adjacent to joints.

3.06 DOWELS

A. Where indicated on Drawings, install dowels at right angles to construction joints and expansion joints. Align dowels accurately with finished surface. Rigidly hold in place and support during concrete placement.
3.07  SETTING ANCHORS

A. Anchor embedded reinforcing, bolts and other items as shown on the Drawings into existing concrete with an epoxy in accordance with these Specifications and all Manufacturer's recommendations.

3.08  SETTING ANCHOR BOLTS

A. Set anchor bolts for structural steel specified in Division 05 - Metals, according to this Section.

B. Install equipment anchor bolts as required by the equipment Manufacturer.

C. Provide accurately made templates for positioning anchor bolts.

3.09  EMBEDDED ITEMS

A. Placement

1. Place embedded items to least impair strength of the structure. Obtain approval of locations for embedded items not shown on the Drawings before placement of concrete. Should locations of embedded items be detrimental to the strength of the structure, notify the Owner's Representative and relocate items as directed by the Owner.

2. Do not cut or reposition reinforcing steel to facilitate installation of inserts, conduit, sleeves, anchor bolts, mechanical openings and similar items without prior approval of the Engineer, except that reinforcing bars may be moved one bar diameter or within tolerances specified in the Concrete Reinforcement section without approval of the Engineer as long as minimum specified reinforcing cover requirements are maintained.

3. It is the Contractor's responsibility to coordinate the requirements for embedded items and to ensure that embedded items are properly placed.

B. Installation

1. Accurately position and support embedded items against displacement during concrete placement.

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

3. Conduits, pipes and inserts of aluminum shall not be embedded in structural concrete unless effectively coated or covered to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

4. Except when plans for conduits and pipes are approved by the Engineer, conduits and pipes embedded within a slab, wall or beam shall satisfy the following:
   a. They shall not be larger in outside dimension than 1/3 the overall thickness of slab, wall or beam in which they are embedded.
   b. They shall not be spaced closer than three diameters or widths on center.
   c. They shall not significantly impair the strength of the member.

END OF SECTION
SECTION 03 20 00

CONCRETE REINFORCING

PART 1  GENERAL

1.01  SCOPE OF WORK

A. This section specifies requirements for all concrete reinforcement.

1.02  RELATED WORK

A. Coordinate the requirements of this section with all other sections of Division 3, Concrete.

1.03  REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM):
   3. ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

B. American Concrete Institute (ACI):
   2. ACI 301: Specifications for Structural Concrete.
   3. ACI 315: Details and Detailing of Concrete Reinforcement.
   4. ACI 318: Building Code Requirements for Structural Concrete.
   5. ACI 350: Code Requirements for Environmental Engineering Concrete Structures.

C. Concrete Reinforcing Steel Institute (CRSI):
   2. CRSI: Placing Reinforcing Bars.

D. American Welding Society (AWS):

E. Wire Reinforcement Institute (WRI):
1.04 SUBMITTALS

A. Submittals shall be made in accordance with all the requirements of the General Conditions and the Contract Documents.

B. Certificates: Submit the Manufacturer’s certificate giving the properties of steel proposed for use. List the Manufacturer’s test number and heat number, chemical analysis, yield point, tensile strength and percent elongation. Also identify on the certificates the proposed location of the steel in the work.

C. Bill of Materials: Submit bills of materials to be reviewed with shop drawings.

D. Shop Drawings:
   1. Show reinforcement fabrication, bar placement location, splices, spacing and bar designation, bar type, length, size, bending, number of bars, bar support type, and other pertinent information, including dimensions. Information must correspond directly to data listed on the bill of materials.
   2. Provide sufficient detail to permit placement of reinforcement without use of design drawings. Reproduction of design drawings for use as shop drawings is not permitted. Do not begin fabrication of reinforcing steel until after shop drawings have been reviewed by the Owner’s Representative.
   3. Detail shop drawings in accordance with ACI 315.
   4. Rebar submittal shall include following information.
      a. Grade of bars.
      b. Table of bending dimensions, bar size, bar length, number of bars and spacing.
      c. The reinforcing shall be listed separately for each structural element (wall, slab, footing, beam, etc.). Each element shall be labeled on the bar list and clearly identified on the shop drawings.
      d. Each bar shall be identified such as corner bars, tie bars, vertical bars, etc.

E. Quality Control Submittals.
   1. Mechanical Threaded Connections.
      a. Provide verification that device threads have been checked and meet all requirements for thread quality, in accordance with manufacturer’s published methods.
   2. Mill Test Reports.
      a. Provide certified copies, evidencing compliance with the requirements of these Specifications, shall be delivered to the Owner with all deliveries of reinforcing steel.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Unloading, storing and handling bars on the job shall meet CRSI publication “Placing Reinforcing Bars”, and the following:
   1. Deliver steel with suitable hauling and handling equipment.
   2. Tag steel for easy identification.
   3. Store reinforcing on blocking or by other means to prevent contact with the ground.
   4. Protect reinforcing, as far as practicable, from mechanical injury, surface deterioration and rusting caused by exposure to the weather.
1.06 NOTIFICATION

A. Notify the Owner’s Representative at least 5 working days before concrete placement so that reinforcement may be inspected and errors corrected without delaying the work.

PART 2 PRODUCTS

2.01 REINFORCEMENT

A. Deformed Bars:
   1. Use Grade 60 deformed bars conforming to ASTM A615 unless indicated otherwise in the drawings.
   2. Where welding of reinforcement is called for in the Drawings, use Grade 60 deformed bars conforming to ASTM A706.

B. Welded Wire Fabric:
   2. Provide wire size, spacing and type as shown.

C. Marking: Clearly mark all bars and welded wire fabric with waterproof tags showing the number of bars, size, mark, length and yield strength. Mark steel with the same designation as the member in which it occurs. Key marks to the concrete placement number as designated on the concrete place sequence shop drawings.

2.02 MECHANICAL CONNECTIONS

A. Reinforcing steel bars shall be spliced with a mechanical connection when called for in the drawings. Splices may also be made with a mechanical connection when permitted by the Engineer in writing.

B. Mechanical Couplers
   1. The mechanical coupler shall meet building code requirements for development in tension or compression. The coupler may be one of two types:
      a. Positive locking, taper threaded type coupler manufactured from high quality steel. The bar ends must be taper threaded using the manufacturer’s requirements.
      b. Mechanical butt splices utilizing lock-shear bolts and internal serrated grip rails within the coupling sleeve.
   2. The mechanical coupler shall develop both tension and compression to a minimum of 125 percent of the specified yield strength of the reinforcing bar.
   3. Acceptable Products and Manufacturers:
      a. LENTON taper threaded couplers as manufactured by ERICO.
      b. Bar Lock mechanical coupler system manufactured by Dayton Superior.

C. Metal Sleeve
   1. Provide with cast filler metal, capable of developing in tension or compression a minimum of 100 percent of specified ultimate tensile strength of the bar and not less than 150 percent of the specified yield strength.
2. Acceptable Products and Manufacturers:
   a. CADWELD Full Tensile Strength Splices, as manufactured by ERICO, or approved equal.

2.03 TIE WIRE

A. Provide 16-gauge, black, soft-annealed wire where tie wire is not closer than 1 inch from surface of form after tying in place.

B. Provide nylon-, epoxy-, or plastic-coated tie wire to fasten non-coated reinforcing steel, unless tie wire is bent to maintain a minimum of 1 inch from surface of form.

C. Provide coated tire wire to fasten epoxy coated reinforcing steel.

2.04 BAR SUPPORTS

A. Provide chairs, riser bars, ties and other accessories made of metal, except as otherwise specified. Bar supports and accessories shall be of the sizes required to provide concrete cover as specified. Metal bar supports and accessories shall be Class 1 or 2 conforming to the requirements of CRSI Manual of Standard Practice.

2.05 FABRICATION

A. Bending:
   1. Shop fabricate bars to the shapes shown on the drawings by cold bending. Bends shall conform to the minimum bend diameters specified in ACI 318. Do not heat, straighten or rebend bars without specific written approval from the Engineer. Field bending of bars is not permitted.

B. Splices:
   1. Locate splices as shown on the drawings. Where it is necessary to splice reinforcement at locations other than shown on the drawings, the splices shall be clearly located in the Shop Drawings for review by the Engineer.
   2. Use a minimum number of splices located at the points of minimum stress. Stagger splices in adjacent bars.
   3. Length of lap splices shall be in accordance with ACI 315, unless called out in the Drawings. When there is a conflict between ACI 315 and the Drawings, the more restrictive provision shall apply.

C. Fabrication Tolerances:
   1. Bars must conform to the fabrication tolerances listed in all reference specifications. When there is a conflict in the reference specifications the more restrictive requirement shall apply.

PART 3 EXECUTION

3.01 GENERAL

A. Meet all requirements of the ACI, CRSI and WRI documents referenced in this Section.
3.02 CLEANING

A. Clean reinforcement of all scale, loose or flaky rust or other foreign material, including oil, mud or coating that will reduce the bond to concrete.

3.03 PLACING REINFORCING BARS

A. Placement in Forms:
   1. Use spacers, chairs, wire ties and other accessory items necessary to properly assemble, space and support reinforcing. Wire ties through forms and temporary spacers will not be allowed.
   2. Provide accessories of sufficient number, size and strength to adequately prevent deflection or displacement of reinforcement due to construction loads or concrete placement. Use appropriate accessories to position and support bolts, anchors and other embedded items. Tie reinforcing bars at each intersection and to accessories. Blocking reinforcement with concrete or masonry is prohibited.

B. Placement for Concrete on Ground:
   1. Support reinforcement on precast concrete blocks spaced at approximately 3 feet on centers each way. Use a minimum of one block for each 9 square feet. Tie blocks to at least one reinforcing bar using tie wires embedded in the block.

C. Placement Tolerances:
   1. Meet the placement tolerances listed in all reference specifications. When there is a conflict in the reference specifications the more restrictive requirement shall apply.

D. Interferences:
   1. If reinforcing interferes with the location of other reinforcing steel, conduits or embedded items, bars may be moved within specified tolerances or one bar diameter whichever is greater. If greater movement of bars is required to avoid interference, notify the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without approval of the Engineer.

E. Protection, Spacing and Positioning:
   1. Conform to reviewed shop drawings, Project Drawings, and all applicable reference specifications. When there is a conflict in the reference specifications the more restrictive requirement shall apply.
   2. Bundle or space bars as approved on shop drawings, instead of bending where construction access through reinforcing is necessary.

F. Splices:
   1. Do not splice bars, except at locations shown on the Drawings or the reviewed Shop Drawings, without approval of the Engineer.
   2. Lap Splices: Tie securely with wire to prevent displacement of splices during placement of concrete.
   3. Stagger splices in adjacent bars.

G. Construction Joints.
1. Place reinforcing continuous through construction joints.

H. Reinforcement Around Openings:
   1. Place an equivalent area of steel around pipe or opening and extend on each side sufficiently to develop bond in each bar unless otherwise noted in the Drawings.
   2. Refer to Details on Drawings for bar extension length of each side of opening.
   3. Where welded wire fabric is used, provide extra reinforcing using fabric or deformed bars.

3.04 PLACING WELDED WIRE FABRIC

A. Install wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus 2 inches, or 6 inches, whichever is larger. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

B. Tie laps and splices securely at ends and at least every 24 inches with 16-gauge black annealed steel wire.

C. Place welded wire fabric on concrete blocks at proper distance above bottom of slab and rigidly support equal to that furnished for typical deformed bar reinforced steel.

D. Do not use fabric that has been rolled. Install flat sheets only.

3.05 WELDING

A. Welding of reinforcement is not permitted unless called for in the Drawings or without written approval of the Engineer.

3.06 FIELD BENDING

A. Field bending of reinforcing steel bars is not permitted without written permission of the Engineer.

3.07 FIELD CUTTING

A. Reinforcing bars cut on the job shall be cut by shearing or sawing. Do not cut bars with a cutting torch.

3.08 MECHANICAL SPLICES AND CONNECTIONS

A. Use only in areas shown in the Drawings or specifically approved in writing by the Engineer.

B. Install as required by Manufacturer.

C. Carefully inspect each splice and verify that each component meets Manufacturer's requirements.

D. Maintain minimum edge distance and concrete cover.

END OF SECTION
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK
   A. This section contains all requirements for cast-in-place structural concrete.

1.02 RELATED WORK
   A. Coordinate the requirements of this section with all other sections of Division 03, Concrete.

1.03 REFERENCE STANDARDS
      1. ASTM C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
      2. ASTM C33: Standard Specification for Concrete Aggregates
      3. ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
      4. ASTM C42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
      8. ASTM C125: Terminology Relating to Concrete and Concrete Aggregates
      9. ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
     13. ASTM C172: Standard Practice for Sampling Freshly Mixed Concrete
     14. ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
     16. ASTM C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
     17. ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
19. ASTM C293: Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
20. ASTM C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
22. ASTM C494: Standard Specification for Chemical Admixtures for Concrete
27. ASTM C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
28. ASTM C683: Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
30. ASTM C827: Standard Test Method for Change in Height at Early Stages of Cylindrical Specimens of Cementitious Mixtures
32. ASTM C856: Standard Practice for Petrographic Examination of Hardened Concrete
33. ASTM C878: Standard Test Method for Restrained Expansion of Shrinkage-Compensating Concrete
34. ASTM C989: Standard Specification for Slag Cement for Use in Concrete and Mortars
35. ASTM C1017: Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
39. ASTM C1218: Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
40. ASTM C1240: Standard Specification for Silica Fume used in Cementitious Mixtures
41. ASTM C1260: Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
42. ASTM C1293: Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
43. ASTM C1602: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
44. ASTM E329: Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

B. American Concrete Institute (ACI).
   1. ACI 117: Specification for Tolerances for Concrete Construction and Materials and Commentary
   2. ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavy-weight and Mass Concrete.
   3. ACI 214: Guide to Strength Test Results of Concrete
   4. ACI 223: Guide for the Use of Shrinkage Compensating Concrete
   5. ACI 301: Specification for Structural Concrete
   6. ACI 302.1: Guide for Concrete Floor and Slab Construction
   7. ACI 304: Guide for Measuring, Mixing, Transporting & Placing Concrete
   8. ACI 304.2R: Placing Concrete by Pumping Methods
   9. ACI 305R: Guide to Hot Weather Concreting
  10. ACI 305.1: Specification for Hot Weather Concreting
  11. ACI 306R: Guide to Cold Weather Concreting
  13. ACI 308: Guide to Curing Concrete
  14. ACI 308.1: Specification for Curing Concrete
  15. ACI 309: Guide for Consolidation of Concrete
  16. ACI 318: Building Code Requirements for Structural Concrete.
  17. ACI 350: Code Requirements for Environmental Engineering Concrete Structures

1.04 SUBMITTALS

A. Submittals shall be made in accordance with all the requirements of the General Conditions and the Contract Documents.

B. Submit for review a proposed design mix for each concrete strength and class required by these Specifications. Failure to include any items of information noted in this paragraph for a given concrete strength or type will be cause for requirement of a resubmittal. Information to be submitted for each strength and class shall include the following items:

1. Concrete mix design
   a. Constituent quantities per cubic yard.
   b. Sources of all concrete mix components including coarse aggregate, fine aggregate, cement, water, admixtures, and pozzolans where included.
   c. Cement type and manufacturer, include chemical analysis (mill test report) for each cement type to be used.
   d. Pozzolan type and source; include chemical analysis for each pozzolan type to be used.
e. Water/cement ratio, by weight.

f. Air content.

g. Mix design slump.

h. Average compressive strengths conforming to the requirements of ACI 318 at 28 days. Provide both average strengths and sample standard deviation. Provide results at 7 and 14 days if available.

i. Laboratory shrinkage test results for concrete mix designs, where specified.

2. Aggregate:

a. Laboratory sieve analysis, conforming to ASTM C33.

b. Verification that aggregate is not "deleterious," or "potentially deleterious." Provide documentation or other certification that aggregate does not contain deleterious substances and has been used without issues on previous projects.

3. Admixtures. Submit Manufacturer’s data brochures on all admixtures proposed for use and provide certification of compliance with specified ASTM standards for each admixture.

C. Submit concrete placement drawings showing pour sequence, lift numbers, locations of all joints, concrete mix being placed, concrete finishes, and all pertinent embedments including embedded plates, sleeves, pipes, conduits, anchors, etc., where applicable. Where the Drawings permit the Contractor to select joint locations, show the selected dimensions on the placement drawings. Approval of the placement drawings shall not relieve the Contractor of the responsibility of placing all concrete and embedments as specified.

D. If cold weather or hot weather concrete conditions are anticipated on the Project, submit a work plan for cold weather concreting and/or for hot weather concreting, describing proposed methods and procedures for mixing, delivering, placing, finishing, and curing concrete. Submit plans well in advance of cold or hot weather job conditions. Include procedures to be implemented upon abrupt changes in weather conditions or due to equipment failures. If a plan for either is not submitted and cold or hot weather concrete conditions are present, the Contractor will not be allowed to pour concrete until a plan is received and reviewed as long as cold or hot weather conditions are present on the Project.

E. Furnish a delivery ticket for ready mixed concrete to the Owner’s Representative as each truck arrives. Each ticket shall provide a printed record of the weight of cement batched and each separate aggregate individually batched. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement, and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of mix trucks.

F. Submit Manufacturer’s data sheets and product specifications for curing compounds and items specified in other Sections including form release agents, bonding agents, etc. Identify the locations where each will be used in the Work as a part of the submittal.

G. Submitted data shall demonstrate compliance with all requirements of this Specification or deviations shall be clearly noted.
1.05 STORAGE OF MATERIALS

A. Cement: Store cement in watertight buildings, bins or silos to provide protection from dampness and contamination. Improperly stored cement shall not be used. No cement shall be used that has been stored on the site for more than 90 days or that is lumped or caked.

B. Aggregate: Arrange and use aggregate stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregates.

C. Sand: Before using, allow sand to drain until a uniform moisture content is reached.

D. Admixtures: Store admixtures to avoid contamination, evaporation or damage. For those used in the form of suspensions or nonstable solutions, provide suitable agitating equipment to assure uniform distribution of ingredients. Protect liquid admixtures from freezing and other temperature changes which would adversely affect their characteristics.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
   1. An experienced installer who has completed concrete work of similar scope and complexity with similar materials as found on this Project.

B. Manufacturer’s Qualifications:
   1. An experienced manufacturer of ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment. Manufacturer must be certified by the National Ready Mix Concrete Association’s Certification of Ready Mixed Concrete Production Facilities.
   2. In accordance with UGC Article 8, Owner will coordinate and pay for routing construction materials testing.

C. Testing Agency Qualifications:
   1. An experienced independent testing agency, acceptable to authorities having jurisdiction and the Engineer that is qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated.

D. Source Limitations:
   1. Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant, each aggregate from a single source and each admixture from the same manufacturer.
   2. Sources of materials may not be changed during the Project without prior written approval of the Engineer.

E. Concrete Consistency
   1. Test for slump shall be performed at the job site immediately prior to placing in accordance with ASTM C143. Slump tests shall be performed for each batch of concrete to indicate workability and consistency from batch to batch.
2. If the slump is outside the allowed limits, the concrete shall be rejected. Concrete showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed or rejected.

3. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, the concrete shall be rejected and changes in the concrete mix shall be made only by an adjustment of one or more of the following:
   a. The gradation of aggregate.
   b. The proportion of fine and coarse aggregate.
   c. The percentage of entrained air, within the allowable limits.

F. Concrete Temperature
1. Concrete temperature shall be taken immediately before placement with the point of measurement being in the chute or bucket.
2. Perform temperature test for each batch and record result on batch ticket.
3. If fresh concrete temperature does not meet requirements in this section the concrete shall be rejected.

G. Concrete Air Content
1. Test for air content shall be made on a fresh concrete sample for each batch prior to placing in forms.
2. Air content for concrete made of ordinary aggregates having low absorption shall be made in accordance with either ASTM C231, or ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, use ASTM C173.
3. If air content of fresh concrete does not meet requirements specified in this Section, the concrete shall be rejected.

H. Compressive Strength
1. Compression test specimens shall be made, cured and tested in accordance with ASTM C31 and ASTM C39.
2. Compressive strength tests shall be made on cylinders at 7 and 28 days. The value of each test result shall be the average compressive strength of a minimum of 2 cylinders taken at the same time from the same batch of concrete.
3. Compressive test specimens shall be 6" x 12" cylinders; 4" x 8" cylinders are not permitted.
4. Sets of concrete test cylinders shall be cast for each concrete pour as follows.
   a. A "set" of test cylinders consists of a minimum of six cylinders, two to be broken and strengths averaged at seven days; and two broken and strengths averaged at 28 days. Two hold cylinders will remain unbroken so that they will be available to be broken upon unforeseen circumstances or upon the option of the Engineer to break cylinders at different times.
   b. A minimum of one “set” of cylinders will be made for each concrete pour up to 25 CY in volume. For pours larger than 25 CY, additional “sets” of cylinders will be made for each additional 25 CY of concrete poured.
5. Evaluation of compressive strength for compliance with design requirements will be conducted by the Engineer per ACI 318 – Section 26.12 based on the results of the 28 day test.

I. Failure to Meet Requirements

1. The Owner may withhold payment for any section of concrete which does not meet the requirements of the Plans and Specifications. Withheld payment shall be based upon unit prices established for concrete, if available. Payment shall be withheld until the unacceptable concrete has been repaired or removed and replaced or otherwise brought into conformance with the Plans and Specifications.

2. Concrete Strength
   a. If the 28 day strength test results fall below required values, additional curing may be performed and test cores may be obtained in accordance with ASTM C42 with approval of the Engineer. Additional curing, core removal and testing, if allowed by the Engineer, shall be at the Contractor’s expense.
   b. If the strength results from test cores do not exhibit the required strength, the Engineer or Owner’s Representative reserves the right to require strengthening, replacement of substandard materials and/or additional testing at the Contractor’s expense. The choice of remedy is at the sole discretion of the Engineer or Owner’s Representative.

3. Other Concrete Properties
   a. If concrete properties besides strength do not meet required values, the Engineer may require concrete samples to be obtained in accordance with ASTM C42 and evaluated in accordance with ASTM C856 at the Contractor’s expense.
   b. If concrete properties besides strength do not meet required values, and the results of additional examination per ASTM C856 are deemed unsatisfactory at the sole discretion of the Engineer, the Owner reserves the right to require strengthening, replacement of substandard materials and/or additional testing at the Contractor’s expense.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cementitious Materials

1. Portland Cement:
   a. Type II or Type I/II conforming to ASTM C 150. Use the same brand of cement upon which the selection of concrete was based. Only one brand of each type will be permitted in any one structure, unless otherwise specified.
   b. Cement shall be low alkali; the total alkali content calculated as the percentage of sodium oxide (Na₂O) plus 0.658 times the percentage of potassium oxide (K₂O) shall not exceed 0.60.
   c. Cement used in concrete placed in openings in existing water bearing structures shall be shrinkage compensating cement, ASTM C845.

2. Fly Ash:
   a. Fly ash, when used, shall meet the requirements of ASTM C618, Class F, except as follows:
      (i) The loss on ignition shall not exceed 4.0%.
      (ii) The maximum percent of sulfur trioxide (SO₃) shall be 4.0%.
b. Fly ash shall be considered a cementitious material for concrete proportioning.

c. Fly ash content shall not exceed 25% by weight of the total cementitious content (Portland cement plus fly ash) of the concrete.

B. Coarse Aggregate

1. Crushed stone or gravel conforming to ASTM C33, in the specified gradation size. Use aggregate from only one source in a single structure. Aggregate shall not be "deleterious," or "potentially deleterious," and shall not contain deleterious substances. Use aggregates from known sources that have a history of use without durability issues.

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<td>3/4&quot;</td>
<td>0-10</td>
<td>90-100</td>
<td></td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>45-80</td>
<td>20-55</td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td>90-100</td>
<td>0-10</td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td>95-100</td>
<td>0-5</td>
<td></td>
</tr>
</tbody>
</table>
C. Fine Aggregate

1. Washed and screened natural sand or sand manufactured by crushing stone conforming to ASTM C33 and meeting the following gradation. Use aggregate from only one source in a single structure. Aggregate shall not be "deleterious," or "potentially deleterious," per ASTM C289 and shall not contain deleterious substances.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Retained</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-15</td>
<td>85-100</td>
</tr>
<tr>
<td>No. 8</td>
<td>90-90</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 16</td>
<td>95-100</td>
<td>0-5</td>
</tr>
</tbody>
</table>

D. Mixing Water: Potable and complying with ASTM C1602.

E. Admixtures: Using the following admixtures as required or permitted. The use of calcium chloride will not be permitted. The products must conform to the referenced standards.

3. Set Retarding Admixtures. Conform to ASTM C494, Types B or D only. Follow all Manufacturer’s recommendations.
4. Water Reducing Admixture. Conform to ASTM C494, types A or D only. Follow all Manufacturer’s recommendations.
5. High-Range Water Reducing Admixtures (HRWR). Conform to ASTM C494 Type F or G only. Follow all manufacturer’s recommendations.
6. Producing Flowing Concrete: Conform to ASTM C1017, Type 1 or 2 only. Follow all manufacturer’s recommendations.
F. Water Soluble Chlorides
   1. Water soluble chloride ion content of all concrete constituents (water, aggregates, cementitious materials and admixtures) shall be measured per ASTM C1218.
   2. Maximum water soluble chloride ion content is limited per ACI 318, Table 19.3.2.1, see the table below.

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Percent by Weight of Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry or Protected from Moisture (C0)</td>
<td>1.00</td>
</tr>
<tr>
<td>Exposed to Moisture but not Chlorides (C1)</td>
<td>0.30</td>
</tr>
<tr>
<td>Exposed to Moisture and Chlorides (C2)</td>
<td>0.15</td>
</tr>
</tbody>
</table>

2.02 CHEMICAL HARDENER
   A. Provide a clear chemical hardener if called for in the Drawings. Coordinate concrete mix design, air content requirements and placement procedures with the chemical hardener manufacturer.
   B. Provide one of the following products:
      1. MASTERTOP 110 ABR/Maximent® HD; by BASF.
      2. Diamond-Plate; by Euclid.
      3. Emeryplate FF, by L&M.

2.03 CURING MATERIALS:
   A. Membrane Curing Compound.
      1. Conform to ASTM C309, commercial curing compound which will not permanently discolor concrete.
      2. All curing compound shall contain a fugitive dye of color strength to render the film distinctly visible on the concrete for at least 4 hours after application.
   B. Sheet Curing Material.
      1. Conform to ASTM C 171.
         a. Waterproof paper
         b. Polyethylene film
         c. White burlap-polyethylene sheeting

2.04 CONCRETE PROPORTIONING
   A. Design Criteria
      1. Use ACI 211.1 as the basis for selecting the proportions of ingredients to produce concrete having proper durability, strength, workability appearance and other required properties. Proportion ingredients to produce a homogenous mixture, which will work readily into corners and angles of forms and around reinforcement by methods of placing and consolidation employed on the work, but without permitting materials to segregate or allowing excessive free water to collect on the surface.
2. **Strength:**
   a. All concrete is required to have an average 28 day compressive strength equal to or greater than specified strength. Establish the required average compressive strength in accordance with ACI 301.

3. **Entrained Air:**
   a. Air-entrain all concrete, unless otherwise specified.
   b. Drilled shafts do not require air entrainment unless placed underwater.
   c. Provide for not less than three percent (3.0%) nor more than six percent (6.0%) by volume of total entrapped and entrained air for normal weight concrete.
   d. Do not air entrain finished floors that call for a troweled finish.

4. **Slump:**
   a. Provide adequate slump to produce acceptable workability, do not exceed maximum specified slump.

5. **Admixtures:**
   a. Proportion admixtures according to the Manufacturer’s recommendations. All admixtures shall be batched at the batch plant only.

### B. Concrete Classification

<table>
<thead>
<tr>
<th>Class</th>
<th>Min. 28-Day Compressive Strength (psi)</th>
<th>Coarse Aggregate Size (in.)</th>
<th>Max. Water Cement Ratio</th>
<th>Max. Slump (in.)</th>
<th>Min. Cement Content (lb. per CY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4000</td>
<td>1.5 (No. 467)</td>
<td>0.45</td>
<td>5</td>
<td>517</td>
</tr>
<tr>
<td>B</td>
<td>3000</td>
<td>1.5 (No. 467)</td>
<td>0.50</td>
<td>4</td>
<td>470</td>
</tr>
<tr>
<td>C</td>
<td>4000</td>
<td>1.0 (No. 57)</td>
<td>0.45</td>
<td>4</td>
<td>564</td>
</tr>
<tr>
<td>D</td>
<td>5000</td>
<td>0.75 (No. 67)</td>
<td>0.45</td>
<td>5</td>
<td>611</td>
</tr>
<tr>
<td>E</td>
<td>1500</td>
<td>1.5 (No. 467)</td>
<td>0.70</td>
<td>4</td>
<td>376</td>
</tr>
<tr>
<td>F</td>
<td>4000</td>
<td>0.375 (No. 8)</td>
<td>0.50</td>
<td>8</td>
<td>611</td>
</tr>
</tbody>
</table>

**NOTE:** Maximum slump shown may be increased to 9 in. if HRWR admixture is used.

### C. Concrete Usage

<table>
<thead>
<tr>
<th>Class</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>All reinforced concrete unless otherwise specified</td>
</tr>
<tr>
<td>B</td>
<td>Concrete Encasement; Sidewalks, Curbs, Driveways</td>
</tr>
<tr>
<td>C</td>
<td>Drilled Shafts; Pumped Concrete; Thin Wall Sections</td>
</tr>
<tr>
<td>D</td>
<td>Precast Concrete and Panels</td>
</tr>
<tr>
<td>E</td>
<td>Lean Concrete Backfill; Foundation Seal; Blocking/Cradling</td>
</tr>
<tr>
<td>F</td>
<td>Underground Duct Banks</td>
</tr>
</tbody>
</table>
2.05 BATCH PLANTS

A. Both on and off site batch plants shall be an established concrete batching facility meeting the requirements of the Concrete Plant Standards of the Concrete Plant Manufacturers Bureau. All batching, mixing and delivery of concrete shall be in accordance with ASTM C94 or ASTM C685.

2.06 CONCRETE MIXING

A. Ready-Mixed Concrete:
   1. Mix and transport ready-mixed concrete according to ASTM C94.
   2. Provide a suitable measuring device capable of measuring mixing water for each batch. Note the number of gallons of water as batched on printed batching tickets.
   3. Compensate for varying moisture contents of both coarse and fine aggregates and change batch weights of materials if necessary before batching.
   4. Provide adequate facilities for accurate measurement and control of each material entering each batch of concrete. Accuracy of weighing equipment must conform to applicable requirements of ASTM and NRMCA for such equipment.
   5. Provide recorders/printers to produce tickets. Each ticket will provide a printed record of volume of water and weights for cement as batched and for separate aggregates as batched individually. Use the type of indicator that returns for zero punch or to zero after a batch is discharged. Clearly indicate by stamped letters or numerals the difference between aggregates and cement as batched. Show the time of day stamped or printed at intervals of not more than six minutes. The delivery ticket shall also show the volume of water, in gallons, added at the batch plant. Deliver recorded ticket copies with concrete. The testing agency will keep one copy.

B. Transit Mix Truck Requirements:
   1. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant.
   2. Transmit mix trucks are to be in good working condition. Trucks which are not mechanically sound, have worn or obstructed mixing fins, have non-functioning drum counters, or leaking water valves shall not be used.
   3. Keep the water tank valve on each transit truck locked at all times that the truck is in use. Any addition of water must be directed by the Engineer. Added water must be incorporated by additional mixing of at least 35 revolutions.
   4. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds. Counter shall be reset to zero at the batch plant. Counters must have reached 70 revolutions, minimum, before concrete may be discharged to ensure uniformity of mixing.
   5. Concrete must be discharged from the transit-mix truck before the drum has revolved 300 revolutions or before 90 minutes from completion of batching, whichever comes first. Concrete that falls outside these limits shall be rejected.

C. Admixtures:
   1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device. Do not use admixtures in powdered form.
2. Two or more admixtures may be used in the same concrete, provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other. Inject the admixtures separately during the batching sequence.

3. Add retarding admixtures as soon as practicable after the addition of cement.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify the Owner's Representative upon completion of various portions of the work required for placing concrete so inspection may be made as early as possible. Keep the Owner's Representative informed of the anticipated concrete placing schedules.

B. All items, including lines and grades, forms, waterstops, reinforcing, inserts, piping, electrical, plumbing and the Contractor's concreting materials and equipment shall be complete and in compliance with the plans and specifications before proceeding with concrete placement.

C. Concrete finishing shall be completed in daylight hours. When this is not possible, brilliantly light the work site so that all operations are plainly visible.

D. Prior to and during concrete placement, forms shall be clean of any and all foreign matter.

E. Mix concrete only in quantities for immediate use. Discard concrete which has set; re-tempering is not permitted. Completely discharge concrete at the site within one hour and 30 minutes after adding cement to aggregate. In hot weather, reduce this time to one hour or less to prevent stiffening of concrete before it is placed.

F. If concrete arrives at the project with slump below that specified, water may be added only if the addition of water does not exceed either the maximum permissible water-cement ratio or maximum slump. Mix adjustments to obtain specified slump must be approved by the Engineer.

G. Protection from Adverse Weather

1. If adverse weather is imminent, no concrete placement is permitted. Do not permit rainwater to increase mixing water or to damage the surface finish. If rainfall occurs after placing operations begin, provide adequate covering to protect the work.

H. Cold Weather Concreting

1. Prevent damage to concrete due to early age freezing and limit rapid changes in temperature at early ages consistent with the requirements of ACI 306R, ACI 306.1 and the requirements in this Section.

2. If the air temperature is at or below 40 degrees F, cold weather concreting shall be performed in accordance with ACI 306R and ACI 306.1. This includes cases where the temperature drops below 40 degrees F after concrete operations have been started. The temperature shall be taken in shade away from artificial heat.

3. When air temperatures are at or below 40 degrees F, heated mixing water or a combination of heated mixing water and heated aggregates shall be used, if required, to raise the concrete temperature at placement to the minimum values (or greater) listed in ACI 306R - Chapter 5. The temperature of the heated water or aggregates shall not exceed 150 degrees F when entering the mixer.
4. Concrete placement is not permitted when the air temperature is at or below 35 degrees F. The temperature shall be taken in shade away from artificial heat.

5. Do not place concrete against a frozen subgrade or formwork that is at or below 35 F.

6. Salts, chlorides, chemicals or other foreign materials shall not be mixed with the concrete to prevent freezing or act as an accelerator.

7. When temperatures at or below 35 F may be expected during the curing period, the concrete shall be maintained at a temperature of at least 50 degrees F for five days or 70 degrees F for three days after placement. Rapid cooling or heating of concrete shall not be permitted.

I. Hot Weather Concreting.

1. Hot weather concreting shall comply with ACI 305R and ACI 305.1. At air temperatures of 90 degrees F or above, concrete placement shall be in accordance with Hot Weather Concreting requirements in ACI 305R, ACI 305.1 and requirements in this Section.

2. The temperature of the concrete when placed in the work shall not exceed 90 degrees F. Use chilled water or ice or other approved methods to reduce the temperature of the concrete as required.

3. Concrete shall be placed in the forms without the addition of any more water than is required by design. No excess water may be added to the concrete surface to aid in finishing. Control of the initial set and extending the time for finishing may be accomplished through the use of admixtures in accordance with these Specifications.

4. Plastic shrinkage cracking, due to rapid evaporation of moisture, shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 pound per square foot per hour, as determined by Figure 4.2 in ACI 305R.

3.02 EMBEDDED ITEMS

A. Refer to Section 03 15 00.

3.03 JOINTS

A. Construction, control, isolation and expansion joints shall be installed and sealed as called for by the Drawings and in accordance with Section 03 15 00.

3.04 WATERSTOPS

A. Waterstops shall be installed as called for by the Drawings and in accordance with Section 03 15 00.

3.05 GROUTING

A. Perform all grouting as called for by the Drawings and in accordance with Section 03 60 00.

3.06 CONCRETE TRANSPORTATION AND CONVEYING

A. Equipment for mixing and transporting concrete shall conform to ASTM C94 or ASTM C685.

B. Delivery tickets shall be required for each batch and shall be in accordance with ASTM C94. Each ticket must clearly show the following:

1. Specific class or designation of concrete.
2. Volume of concrete
3. Amount of water, in gallons, that can be added to the mixer truck at the site without exceeding the maximum water-cement ratio for that mix design.
4. Time of batching cement, water and aggregates and initial reading of revolution counter if counter not zeroed.

C. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Use methods which prevent loss of ingredients and segregation.
   1. Troughs, chutes and pipes shall be steel or steel lined.
   2. When steep slopes are necessary, provide baffles.
   3. Keep chutes, troughs and pipes clean and free from coatings of hardened concrete.
   4. Concrete pumping is permitted and shall comply with ACI 304.2R.

3.07 CONCRETE PLACEMENT

A. Preparation
   1. Sprinkle semi-porous subgrades to eliminate suction.
   2. Seal extremely porous subgrades in an approved manner.
   3. Clean and prepare existing concrete surface in accordance with these Specifications prior to placing new concrete.

B. General
   1. Deposit concrete continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of cold joints, seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
   2. Proceed with placement at a rate such that concrete which is being integrated with fresh concrete is still plastic. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
   3. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only if made of galvanized metal or concrete, and if prior approval has been obtained.
   4. Do not start placing of concrete in supported elements until concrete previously placed in columns and walls is no longer plastic.
   5. Deposit concrete as nearly as practicable in its final position to avoid segregation. Do not subject concrete to a procedure which will cause segregation.
   6. Deposit concrete through vertical drop chutes of rubber or metal of satisfactory size when operations involve placing concrete from above.
   7. Concrete shall not be dropped more than 10 feet when HRWR admixture is used and 5 feet without HRWR.
   8. Where surface mortar is to be the basis of a finish, especially those designated to be painted, work coarse aggregate back from forms with a suitable tool to bring the full surface of mortar against the form. Prevent formation of excessive surface voids.
C. Slabs
   1. After suitable bulkheads, screeds and if specified, jointing materials, have been positioned
      the concrete shall be placed continuously between construction joints, beginning at a
      bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously
      placed concrete to avoid stone pockets and segregation.
   2. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded
      and consolidated at the edge of that previously placed to avoid cold joints.
   3. Concrete shall then be brought to correct level with a straightedge and struck off.
      Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or
      hollows.

D. Formed Concrete
   1. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom
      of tremie tubes shall be in contact with the concrete already placed.
   2. In walls, place concrete in 12" to 24" lifts, keeping the surface horizontal. Compaction
      shall be by vibrator and shall be supplemented by hand puddling; puddling shall be
      continuous while pouring concrete and shall be done primarily between forms and
      reinforcing steel, around openings, or wherever needed to prevent honeycomb, fill voids or
      drive out large air bubbles.

E. Concrete Poured Against Rock
   1. Where concrete is poured against undisturbed rock, especially in drilled shafts, place
      concrete as soon as practicable after excavation to prevent weathering of exposed rock.
      a. For footings and slabs, place mud slabs within 4 hours after the excavation is at final
         grade.
   2. Remove all water from excavation or shaft before placing concrete.

3.08 CONSOLIDATION OF CONCRETE
A. All concrete shall be placed and consolidated with mechanical vibrators.
   1. A minimum frequency of 7000 revolutions per minute is required for mechanical
      vibrators.
   2. Do not use vibrators to transport concrete within forms.
   3. Insert vibrators and withdraw at points from 18 to 30 inches apart. At each insertion,
      vibrate sufficiently to consolidate concrete, generally until a liquefied appearance is
      produced on the surface. Do not over-vibrate causing segregation.
   4. Keep a spare vibrator on the site during concrete placing operations. No concrete shall be
      ordered until sufficient approved vibrators (including standby units in working order) are
      on the job.

B. Concrete for slabs shall be compacted with vibrating screeds and internal vibrators.
C. Internal vibrators shall be exclusively used; form attached vibrators are not permitted.

3.09 FINISHING OF FORMED SURFACES
A. Forms shall be removed as specified in Section 03 10 00. Patch, repair, finish and clean concrete within 7 days of form removal in accordance with the Specifications. Cure concrete as finishing progress in accordance with the Specifications.

B. No Finish: A finish is not required on surfaces which are not visible from the inside or outside of the structure or more than 12 inches below finished grade.

C. Smooth Form Finish:
   1. Unless otherwise specified, all surfaces not meeting the requirements for “no finish” shall receive a smooth form finish. Use a smooth form finish on all surfaces exposed to view and liquid.
   2. Provide a smooth, hard uniform texture on the concrete surface. Use plywood or fiberboard linings or forms in as large sheets as practicable and with smooth, even edges and close joints.
   3. Patch tie holes and defects.
   4. Provide a smooth, uniform, rubbed surface texture. Rub fins and joint marks and other irregularities with carborundum stone immediately after forms are stripped to leave a smooth, unmarred finish surface. If rubbing of surface is delayed to the point where the concrete surface is dry and cannot be rubbed to produce a smooth, uniform surface Contractor shall provide a blast finish to achieve a smooth uniform surface at no additional cost to the Owner.

D. Related Unformed Surfaces: Tops of piers, walls, bent caps and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed. Float unformed surfaces to a texture reasonably consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly across the unformed surfaces.

3.10 FINISHING SLABS AND SIMILAR FLAT SURFACES

A. Comply with the recommendations in ACI 302.1R for screeding, restraightening and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Finish slabs and similar flat surfaces monolithically and apply as indicated in the Plans and as follows:
   1. Rough Finish.
      a. Tank floors and slabs that receive grout or additional concrete toppings.
      b. Provide a rough surface by screeding only without further finish.
   2. Trowel Finish
      a. Slab surfaces exposed to view, liquids or to be covered with a coating system, flooring coverings or membranes.
      b. After apply float finish, apply trowel finish and consolidate by hand or power driven trowel. Continue troweling passes and restreighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   3. Broom Finish
      a. Sidewalks, walkways and platforms.
      b. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
3.11 CONCRETE CURING

A. All concrete shall be cured in accordance with the Specifications. The curing methods shall be wet curing, sheet materials or membrane curing compound. Unless the curing method is specified otherwise, select one of the appropriate curing methods below.

B. Length of Curing Period

1. A “curing day” shall be any day on which the atmospheric temperature taken in the shade, or the air temperature adjacent to the concrete, remains above 50 degrees F for at least 18 hours.

2. Continuously cure concrete for a period until 7 curing days have been reached. In cold weather, curing may be terminated after a period of 14 consecutive days.

C. Wet Curing

1. Immediately after the finishing operations are completed or forms are stripped, the concrete shall be covered with wet cotton mats or with a temporary covering of canvas or burlap, thoroughly saturated with water before placement. A temporary covering shall be used when factors dictate that cotton mats cannot be placed immediately after finishing operations without marring the finishing of the concrete surface.

2. When temporary coverings are used keep them in place only until the surface has sufficiently hardened so that a cotton mat can be substituted without marring or disturbing the concrete finish.

3. The coverings shall remain in contact with the concrete for the duration of the curing period.

4. The coverings shall be kept saturated with water for the entire curing period.

5. Water used for curing shall be potable and free from any injurious materials or deleterious substances.

D. Sheet Curing

1. Immediately after the finishing operations are completed or forms are stripped, install sheet curing materials in accordance with all Manufacturer’s recommendations.

2. Sheet curing shall be in contact with the entire concrete surface so as to prevent drying for the duration of the curing period.

3. When pedestrian traffic is unavoidable, provide suitable walkways to protect the sheet material.

E. Membrane Curing

1. Membrane curing compound is not permitted on surfaces to be rubbed or on surfaces to receive additional concrete, grout, plaster or coatings.

2. Immediately after the finishing operations are completed or forms are stripped, apply membrane curing compound solution under pressure with a spray nozzle so the entire exposed surface is completely covered with a uniform film. The rate of application shall insure complete coverage but shall not exceed 150 square feet per gallon of curing compound.

3. After application and under normal conditions, the curing compound shall be dry to the touch within 1 hour and shall be dry thoroughly and completely within 4 hours. When
thoroughly dry it shall provide a continuous flexible membrane free from cracks and pinholes and shall remain intact during the required curing period.

4. If the membrane seal is broken during the curing period, immediately repair it with additional curing compound.

F. After the curing period, the temperature of the exposed surface shall not be permitted to drop faster than 30 degrees F in 24 hours.

3.12 CONCRETE SURFACE REPAIRS

A. Repair defective areas immediately after the removal of forms in accordance with this Section and Section 03 01 30. Repair of defective areas shall be at no additional cost to the Owner.

B. If the concrete surface is bulged, uneven or exhibits defects which in the Engineer’s opinion cannot be satisfactorily repaired, remove and replace the entire concrete section as directed at no additional cost to the Owner.

C. Patch tie holes immediately after removal of forms. After cleaning and thoroughly dampening the tie hole, fill solid with non-shrink, non-metallic grout.

3.13 FIELD QUALITY CONTROL

A. Concrete Testing

1. General
   a. Tests shall be required throughout the work to monitor the quality of concrete. Take all samples in accordance with ASTM C172.
   b. Testing of concrete shall be conducted by an independent, qualified testing agency.

END OF SECTION
SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install grout.

1.02 RELATED WORK

A. Coordinate the requirements of this section with all other sections of Division 03, Concrete.

1.03 REFERENCE STANDARDS

A. American Concrete Institute (ACI)
   1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavy-Weight and Mass Concrete.
   2. ACI 301, Specification for Structural Concrete.

   1. ASTM C33, Specification for Concrete Aggregates.
   5. ASTM C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic surfacings and Polymer Concrete.
   8. ASTM C882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

1.04 SUBMITTALS

A. Grout Mix Design:
1. For Grout Fill, submit the following:
   a. grout mix design
   b. laboratory test reports for grout strength tests.

B. Reports and Certificates, submit the following:
   1. For proprietary materials, submit copies of Manufacturer's certification of compliance with the specified properties for Class I, II, and III grouts.
   2. Certified testing lab reports for tests specified herein for nonproprietary materials.
   3. Certifications that all grouts used on the project are free of chlorides or other chemicals causing corrosion.
   4. Manufacturer's specifications and installation instructions for all proprietary materials.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Grout materials from Manufacturers shall be delivered in unopened containers and shall bear intact manufacturer's labels.

B. Storage of Materials:
   1. Grout materials shall be stored in a dry shelter and shall be protected from moisture.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
   1. An experienced installer who has completed grout work of similar scope and complexity with similar materials as found on this Project.

B. Testing Agency Qualifications:
   1. An experienced independent testing agency, acceptable to authorities having jurisdiction and the Engineer that is qualified according to applicable ASTM standards to conduct the testing indicated.

C. Field Tests
   1. All test specimens and testing will be made and conducted by the Owner or its representative.
   2. Compression test specimens shall be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the Engineer to ensure continued compliance with these specifications.
   3. Compression tests and fabrication of specimens for non-shrink grout shall be performed as specified in ASTM C109. A set of three specimens will be made for testing at seven days, 28 days, and each additional time period as appropriate.
   4. Compression tests and fabrication of specimens for epoxy grout shall be performed as specified in ASTM C579, Method B. A set of three specimens will be made for testing at seven days, and each earlier time period as appropriate.
PART 2  PRODUCTS

2.01  GROUTS

A.  General

   1.  Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer’s instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout specified herein shall be that recommended by the Manufacturer for the particular application.

B.  Class I Non-Shrink Grout:

   1.  Required minimum 28 day compressive strength is 7000 psi.

   2.  Shall meet the requirements of ASTM C1107 and the minimum compressive strength requirements when tested using the amount of water required to achieve the following properties:

       a.  Flowable consistency (125 to 145 percent flow on ASTM C230, five drops in 3 seconds).

   3.  The grout shall not bleed when tested at maximum allowed water.

   4.  The non-shrink property is not based on a chemically generated gas or gypsum expansion.

   5.  Product and Manufacturer: Provide one of the following:

       a.  Master Flow 100, as manufactured by BASF Building Systems.

       b.  Five Star Grout, as manufactured by Five Star Products.

C.  Class 2 Non-Shrink Grout:

   1.  Required minimum 28 day compressive strength is 7000 psi.

   2.  Shall meet the requirements of ASTM C1107 Grades B and C and minimum compressive strength requirements when tested using the amount of water required to achieve the following properties:

       a.  Fluid consistency (20 to 30 seconds in accordance with ASTM C 939).

   3.  The length change from placement to time of final set shall not have a shrinkage greater than the amount of expansion measured at 3 or 14 days. The expansion at 3 or 14 days shall not exceed the 28-day expansion.

   4.  The non-shrink property is not based on a chemically generated gas or gypsum expansion.

   5.  Product and Manufacturer: Provide one of the following:

       a.  Masterflow 928, as manufactured by BASF Building Systems.

       b.  Five Star Fluid Grout 100, as manufactured by Five Star Products, Inc.

D.  Class 3 Non-Shrink Epoxy Grout:

   1.  Epoxy grout shall be a pourable, non-shrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted, unless specifically recommended by the Manufacturer. Manufacturer’s instructions shall be printed on each container in which the materials are packaged.
2. Required minimum 7 day compressive strength is 13,000 psi when tested in accordance with ASTM C579.

3. The following properties shall be attained with the minimum quantity of aggregate allowed by the manufacturer.
   a. The vertical volume change at all times before hardening shall be between 0.0 percent shrinkage and four percent expansion when measured according to ASTM C827 (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1). Alternately, epoxy grouts which maintain an effective bearing area of not less than 95 percent are acceptable.
   b. The length change after hardening shall be negligible (less than 0.0006 in/in) and the coefficient of thermal expansion shall be less than 0.00003 in/in/F when tested in accordance to the requirements of ASTM C531.
   c. The compressive creep at one year shall be negligible (less than .001 in/in) when tested under a 400 psi constant load at 140°F in accordance to the requirements of ASTM C1181.
   d. The grout shall be capable of maintaining at least a flowable consistency for a minimum of 30 minutes at 70°F.
   e. The shear bond strength to Portland cement concrete shall be greater than the shear strength of the concrete when tested in accordance to the requirements of ASTM C882.
   f. The effective bearing area shall be a minimum of 95 percent.

4. Product and Manufacturer: Provide one of the following:
   a. Sikadur 42 Grout Pak, as manufactured by Sika Corporation.
   b. DP Five Star Epoxy Grout, as manufactured by Five Star Products.

E. Grout Fill & Topping Grout:

1. Grout for topping of slabs and concrete fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as specified herein. All materials and procedures specified for normal concrete in Section 03 30 00 shall apply except as noted otherwise herein.

2. Topping grout and concrete fill shall contain a minimum of 517 pounds of cement per cubic yard (5.5 sacks) with a maximum water cement ratio of 0.45.

3. Minimum 28 day compressive strength shall be 4000 psi.

4. Coarse aggregate shall be No. 8 (3/8" max) per Section 03 30 00.

5. Fine aggregate shall be as required in Section 03 30 00.

6. Slump shall be adjusted to match placement and finishing conditions, but shall not exceed 4 inches.

7. Final mix design shall be as determined by trial mix design under supervision of the approved testing laboratory.

8. Where grout placement is thicker than 4 inches, use Class A concrete as specified in Section 03 30 00.

F. Requirements for Grout Fill and Topping Grout
1. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for grout required. Comply with ACI 211.1 and report to Engineer the following data:
   a. Complete identification of aggregate source of supply.
   b. Tests of aggregates for compliance with specified requirements.
   c. Scale weight of each aggregate.
   d. Absorbed water in each aggregate.
   e. Brand, type and composition of cement.
   f. Brand, type and amount of each admixture.
   g. Amounts of water used in trial mixes.
   h. Proportions of each material per cubic yard.
   i. Gross weight and yield per cubic yard of trial mixtures.
   j. Measured slump.
   k. Measured air content.
   l. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven day and 28 day test, and for each design mix.

2. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301, Section 4.

3. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301, Section 4.

4. Admixtures: Use air-entraining admixture in all grout. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control. Do not use admixtures which have not been incorporated and tested in the accepted design mix, unless otherwise authorized in writing by Engineer.

G. Grout Applications: The following is a listing of typical applications and the corresponding type of grout which is to be used. Unless indicated otherwise in the Drawings, grouts shall be provided as listed below.

<table>
<thead>
<tr>
<th>Application</th>
<th>Grout Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Base Plates</td>
<td>Class 1</td>
</tr>
<tr>
<td>Column Base Plates</td>
<td>Class 2</td>
</tr>
<tr>
<td>Equipment &amp; Tank Base Plates</td>
<td>Class 2</td>
</tr>
<tr>
<td>Machinery Base Plates</td>
<td>Class 3</td>
</tr>
<tr>
<td>Filling blockout spaces for embedded items (railing posts, gate guide frames, etc.)</td>
<td>Class 2</td>
</tr>
<tr>
<td>Toppings &amp; fill 4 inches or less</td>
<td>Grout Fill &amp; Topping Grout</td>
</tr>
<tr>
<td>Toppings &amp; fill greater than 4 inches</td>
<td>Class A Concrete (Section 03300)</td>
</tr>
<tr>
<td>All other applications</td>
<td>Class 1</td>
</tr>
</tbody>
</table>
2.02 CURING MATERIALS
   A. Curing materials shall be as specified in Section 03 30 00 and as recommended by the Manufacturer of prepackaged grouts.

2.03 CONSISTENCY
   A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application.

PART 3 EXECUTION

3.01 INSPECTION
   A. Contractor shall examine the substrate and conditions under which grout is to be placed and notify Engineer, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.02 INSTALLATION
   A. General:
      1. Place grout as shown on the Drawings and in accordance with manufacturer's instructions. If Manufacturer's instructions conflict with the Specifications do not proceed until Engineer provides clarification.
      2. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions.
      3. Placing grout shall conform to temperature and weather limitations in Section 03 30 00.
      4. Grout shall be cured following Manufacturer's instructions for prepackaged grout and the requirements in Section 03 30 00.

   B. Columns, Beams and Equipment Bases:
      1. After shimming base plate to proper grade, securely tighten anchor bolts. Properly form around the base plates, allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with the grout.

   C. Handrails and Railings:
      1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the grout. Bevel grout at juncture with post so that moisture flows away from post.

   D. Topping Grout:
      1. All mechanical, electrical, and finish work shall be completed prior to placement of topping grout. The base slab shall be given a roughened textured surface by sandblasting or hydro-blasting exposing the aggregates to ensure bonding to the base slab.
      2. Apply topping grout as shown in the Drawings; the minimum thickness of grout topping shall be 1-inch.
      3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping shall be placed until the slab is complete free from standing water. A thin coat of
neat Type II cement slurry shall be broomed into the surface of the slab and topping shall be placed while the slurry is still wet. The topping shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment Manufacturer after the grout is brought to the established grade.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

6. Cure and protect the grout topping as specified in Section 03 30 00.

E. Grout Fill

1. All mechanical, electrical, and finish work shall be completed prior to placement of grout fill. Grout fill shall be mixed, placed, and finished as required in Section 03 30 00.

2. The minimum thickness of grout fill shall be 1 inch. Where the finished surface of grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3 1/2 inches wide by 1 1/2 inches deep.

3. The surface shall be tested with a straight edge to verify that the surface slopes uniformly to drain and to detect high and low spots which shall be immediately eliminated. When the grout fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

END OF SECTION
SECTION 05 05 00

ANCHOR BOLTS

PART 1  GENERAL

1.01  SCOPE OF WORK

A. This section specifies anchor bolts and embedded anchorages into concrete.

1.02  RELATED WORK

A. Division 03 - Concrete
B. Division 05 - Metals
C. Coordinate work of this section with all other sections to obtain a proper installation. Review all drawings, specifications and manufacturer's requirements for additional requirements for anchor bolts and anchorages.

1.03  REFERENCE STANDARDS

A. American Institute of Steel Construction (AISC).

B. American Concrete Institute (ACI)
   1. ACI 318: Building Code Requirements for Structural Concrete
   2. ACI 350: Code Requirements for Environmental Engineering Concrete Structures

C. International Code Council (ICC)
   1. International Building Code (IBC)

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

E. American Society for Testing and Materials (ASTM):
   4. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   5. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Submit shop drawings as specified and required in the Contract Documents. Give sufficient detail to permit anchor bolt installation without referring to design drawings.
   2. Drawings must include all anchor bolts and embedded anchorages, bolt setting and erection templates.
   3. Provide Manufacturer’s specifications, load tables and installation instructions.
   4. Erection drawings shall be sealed by a Licensed Professional Engineer in the State in which the project is will be built.
   5. Provide a letter sealed by a Licensed Professional Engineer in the State in which the project will be built stating that all anchor bolts and anchorages not specifically shown on the structural drawings are adequate for the application and meet all design requirements in the Drawings and referenced codes.

1.05 PRODUCT DELIVERY AND STORAGE

A. If materials must be stored, keep them off the ground and clean, free of dirt, mud, grease or oil. Protect bolts and anchorages from corrosion and/or deterioration.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

A. When the size, length, and material or load carrying capacity of the anchor bolts or anchorages are not shown in the Drawings, provide the following:
   1. For cast-in-place anchor bolts or anchorages:
      a. Provide the material type, size, length, and arrangement required to resist all loads and load combinations given in the latest version of the IBC Building Code, ASCE-07 and the Drawings. In the case of conflicting requirements, the most restrictive requirements will control.
   2. For post-installed anchor bolts or anchorages:
      a. Provide the material type, size, length, minimum embedment and arrangement required to resist all loads and load combinations given in the latest version of the IBC Building Code, ASCE-07 and the Drawings. In the case of conflicting requirements, the most restrictive requirements will control.
      b. Provide required adhesive and installation requirements.

2.02 MATERIALS

A. Anchor Bolts:
   1. Provide anchor bolts as shown in the Drawings.
2. Provide stainless steel anchor bolts and hardware complying with ASTM F593, Condition CW, AISI Type 316 headed with stainless steel nuts and washers.

3. For equipment, provide 316 stainless steel anchor bolts that meet the manufacturer's requirements for size and strength. Comply with manufacturer's requirements for embedment length and projection.

4. Protect threads and shank from damage during placement of concrete, installation of equipment and erection of structural steel.

B. Adhesive Anchors:
   1. Provide stainless steel adhesive anchors and hardware complying with ASTM F593, Condition CW, AISI Type 316 headed with stainless steel nuts and washers.
   2. Adhesive system shall be Hilti HIT-HY200 adhesive, by Hilti. No substitutions will be considered.
   3. Embedment depth of the anchor shall provide concrete breakout and pullout strength equal to the steel tensile capacity of the anchor, unless otherwise noted in the Drawings. Reduction in concrete breakout and pullout strength due to spacing and edge distances shall be made.

C. Expansion Anchors
   1. Expansion anchors will not be allowed for structural connections unless specifically called for in the Drawings.
   2. Where expansion anchors are called for in other sections, provide Type 316 stainless steel expansion anchors.
      a. Kwik Bolt by Hilti,
      b. Easy-Set by Simpson, or
      c. Approved equal.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Assure that embedded items are protected from damage and are not filled in with concrete.
   B. Set bolts as shown in the Drawings or as required using templates or other devices to insure accurate placement and to prevent drift during concrete placement.
   C. Fully consolidate plastic concrete around anchor bolts per the requirements Division 03 Sections.
   D. For adhesive anchors and adhesive materials, Contractor shall comply with all Manufacturer's installation instructions. Properly clean out holes per manufacturer's required procedures prior to installation of adhesive.

3.02 CLEANING
   A. After embedding concrete is placed, remove protection and clean bolts and inserts.

END OF SECTION
SECTION 05 50 00

METAL FABRICATIONS

PART I  GENERAL

1.01  SCOPE OF WORK

A. This section specifies metal elements including but not limited to the following. All items listed are not necessarily included in the project, see Project Drawings for specific project requirements.
   1. Shelf angles.
   2. Steel framing and supports for equipment and where framing and supports are not specified in other Sections.
   3. Pipe bollards.
   4. Prefabricated access hatches.
   5. Miscellaneous aluminum construction.

1.02  RELATED WORK

A. Division 03 – Concrete
B. Division 05 – Metals
C. Division 09 – Finishes

1.03  REFERENCE STANDARDS

A. International Code Council
   1. International Building Code (IBC)

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

C. The Aluminum Association

D. American Institute of Steel Construction (AISC).

E. American Welding Society (AWS):
   1. D1.1 Structural Welding Code - Steel.
   2. D1.2 Structural Welding Code – Aluminum
   3. D1.3 Structural Welding Code – Sheet Steel
   4. D1.6 Structural Welding Code – Stainless Steel

F. American Society for Testing and Materials (ASTM):
7. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
13. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
15. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process


G. The American Society of Safety Engineers (ASSE)
   1. ASSE A1264.1, Safety Requirements for Workplace Walking/Working Surfaces & Their Access; Workplace Floor, Wall & Roof Openings; Stairs & Guardrails Systems

H. The Society for Protective Coatings (SSPC):

I. United States Department of Labor:
   1. OHSA Regulations (Standards - 29 CFR); Part 1926 - Safety and Health Regulations for Construction.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Submit shop drawings as specified and required in the Contract Documents.
   2. Submit detailed shop drawings showing sizes of members, method of assembly, anchorage, and connection to other members for approval prior to fabrication.
   3. Provide a letter sealed by a Licensed Professional Engineer in the State which the project will be built stating that all connections not specifically shown on the design structural drawings have been designed and detailed under his supervision.

B. If design and details for systems and elements are not shown in the Drawings, provide a letter sealed by a Licensed Professional Engineer in the State which the project will be built stating that the proposed design and details have been designed and detailed under their supervision and meet all codes referenced by this Section and requirements of this Section.

C. Certificates: Submit certified mill reports from the material supplier. Reports must provide heat or melt number mill analysis and test results for structural steel. If reports are not submitted or if the material cannot be positively identified and directly related to the reports, material quality tests will be required at no cost to the Owner.

1.05 COORDINATION

A. The Work of this Section shall be completely coordinated with the Work of other Sections. Verify at the Site the dimensions and the Work of other trades adjoining items of Work in this Section before fabricating or installing the items specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the Work of other Sections.
1.06 PRODUCT DELIVERY AND STORAGE

A. Schedule material delivery so that items may be installed promptly after arrival.

B. If materials must be stored, keep them off the ground and clean, free of dirt, mud, grease or oil. Store in such a manner to avoid member distortion. Protect steel from corrosion and/or deterioration.

PART 2 PRODUCTS

2.01 GENERAL

A. For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 ALUMINUM

A. Materials
   1. Aluminum structural shapes, bars and plates:
   2. Extruded aluminum pipe:
      a. Alloy 6063-T6 or 6061-T6.
   3. Aluminum Castings:
      a. Alloy 535.

B. Fabrication
   1. Follow general fabrication requirements elsewhere in this Section.
   2. Fabricate miscellaneous aluminum shapes and plates as shown. Furnish welded and mitered angle frames and other fabrications complete with welded anchors attached. Furnish all miscellaneous aluminum shown but not otherwise detailed. Structural shapes and extruded items shall comply with the dimensions on the Drawings within the tolerances published by the Aluminum Association.
   3. Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration of exposed aluminum surfaces.

C. Finishes
   1. All exposed aluminum surfaces shall have anodized finish unless otherwise specified. Apply a coat of methacrylate lacquer to all aluminum before shipment.

2.03 FERROUS METALS

A. Structural Steel:
   1. All rolled structural shapes, plates and bars must meet the standards for ASTM A992 and ASTM A572, Grade 50 unless otherwise shown in the Drawings.
   2. Clip angles, stiffeners, plates and other detail items must conform to standards of the main member to which the items are attached unless noted otherwise.

B. Steel Pipe
   1. Conform to ASTM A53, Type E or S, Grade B, welded or seamless. No hydrostatic tests required.
C. Structural Steel Tubing:
   1. Conform to ASTM A500, Grade B, with minimum yield strength of 46,000 psi. No hydrostatic tests required.

D. Stainless Steel:
   1. Use the stainless steel grade indicated on the drawings (304 or 316). Where the grade is not specified use AISI 316. Use a weldable (304L or 316L) grade of stainless steel for welded items.
   2. For all stainless steel, required minimum yield strength is as follows unless otherwise noted on the Drawings.
      a. 304 or 316: 30,000 psi.
      b. 304L or 316L: 25,000 psi.

E. Slotted Channel Framing:
   1. Galvanized steel cold-formed metal channels with flange edges returned toward web and with 9/16-inch wide slotted holes in webs at 2 inches on center.
   2. Fabricate from steel conforming to ASTM A1101, GR 33.
   3. Channel width:
      a. As indicated on the Drawings.
   4. Channel depth:
      a. As indicated on the Drawings.

F. Gray-Iron Castings:
   1. Gray iron castings conforming to ASTM A48, Class 30 unless another class is indicated or required by structural loads.

2.04 FASTENERS
   A. Provide ASTM F593, Type 316 fasteners for exterior use or when called for in the Drawings.
   B. Structural Steel Bolts, Nuts & Washers
      1. Bolts & Nuts:
         a. Use high-strength bolts, conforming to ASTM A325 with hex nuts.
      2. Washers
         b. Lock washers, use helical, spring type, carbon steel, ASME B18.22.1.

2.05 SHELF ANGLES
   A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated in the Drawings.
   B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete. Align expansion joints in angles with indicated control and expansion joints in cavity-wall exterior wythe.
   C. Galvanized shelf angles to be installed in exterior walls.
   D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete unless otherwise indicated in the Drawings.
2.06 PIPE BOLLARDS

A. Fabricate pipe bollards from Schedule 80 steel pipe. Cap bollards consistent with details in the Drawings.

B. Where indicated, fabricate bollards with steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for anchor bolts. Base plate and anchor bolts size shall be as shown on Drawings. Where bollards are to be anchored to sloping concrete slabs, angle base plates for plumb alignment of bollards.

2.07 PREFABRICATED ACCESS HATCHES

A. Hatches:

1. General Requirements:
   a. Provide prefabricated access hatches of the sizes and types shown on the Drawings.
   b. Door leaf(s) shall be aluminum diamond plate as shown on Drawings.
   c. Unless otherwise noted on the Drawings, use pivot torsion bars for counterbalance or spring operators for easy operation. Doors shall open to 90 degrees with automatic door hold open and shall be provided with a grip handle to release the cover for closing.
   d. Hardware shall be durable and corrosion resistant with Type 316 stainless steel hardware used throughout. Provide removable lock handle.
   e. Provide factory mill finish and bituminous coating to the exterior of the frames. Where specified to be watertight, a 1-1/2-inch drainage coupling shall be provided in the perimeter channel frame.
   f. Break bond between dissimilar metals using a heavy coat of alkali resistant bituminous paint, or other coating recommended by the Manufacturer that will provide equivalent protection. Otherwise, hatches used at exposed exterior locations shall be weather stripped or sealed to resist penetration of water. Embedded frame with embedment anchors shall be supplied by the hatch Manufacturer.
   g. Manufacturers shall provide access hatch with aluminum safety grating panel installed beneath access covers to provide additional protection against fall through accidents when the cover is left in the open position. The aluminum grating panel shall be designed, anchored, etc., by the hatch Manufacturer.

2. Load Requirements:
   a. Pedestrian Access Only:
      (i) Hatches subjected to pedestrian access only shall be designed to withstand an unfactored live load of 125 pounds per square foot.
   b. Vehicular Access:
      (i) Hatches subjected to vehicular traffic shall be designed to withstand an unfactored concentrated wheel loading (live load) of 16,000 lbs with an impact factor of 1.33 over a 20 inch by 10 inch tire contact area or an unfactored live load of 250 pounds per square foot, whichever produces the greatest stresses.

3. Acceptable Manufacturers: Subject to compliance with requirements, provide prefabricated roof hatch units by one of the following:
   a. Halliday Products, Inc., Orlando, FL.
   b. Bilco Company; New Haven, CT.
      (i) Type J for Single Leaf,
      (ii) Type JD for Double Leaf, or
(iii) Approved equal.

B. Roof Scuttles:
   1. General Requirements:
      a. Provide prefabricated roof scuttles of the sizes and types shown on the Drawings.
   2. Cover:
      a. Galvanized steel with 3-inch bedded flange, neatly welded. Curb shall be 12-inch in
         height and galvanized steel.
      b. Cover shall be equipped with an automatic hold-open arm complete with vinyl grip
         handle to permit easy release.
      c. Equip units with complete hardware set including padlock, and both interior and
         exterior hatch handles. All hardware shall be Type 316 stainless steel.
   3. Provide factory mill finish and bituminous coating to the exterior of the frames. Break
      bond between dissimilar metals as specified for Hatches.
   4. Roof Scuttles shall be weather stripped or sealed to resist penetration of water as required.
      Embedded frame with embedment anchors shall be supplied by the Manufacturer.
   5. Acceptable Manufacturers: Subject to compliance with requirements, provide
      prefabricated roof scuttle units by one of the following:
      a. Halliday Products, Inc., Orlando, FL,
      b. Bilco Company; New Haven, CT, or
      c. Approved equal.

2.08 GALVANIZING
   A. Hot-dipped zinc coat structural items specifically designated as galvanized after fabrication.
      Conform to the applicable standard, ASTM A123 or ASTM A153.
   B. Use repair coating which conforms to ASTM A780. Acceptable products include:
      1. Carboline Carbo Zinc No. 11.
      2. Galv-Weld Products Galv-Weld Alloy.
   C. Unless otherwise noted all structural steel shall be galvanized.

2.09 FABRICATION
   A. Fabricate according to industry reference standards, codes, and these specifications unless
      directed or shown otherwise.
   B. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly.
      Disassemble units only as necessary for shipping and handling limitations. Use connections that
      maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated
      installation.
   C. Shear and punch metals cleanly and accurately. Remove burrs.
   D. Ease exposed edges to a radius of approximately 1/32-inch (1 mm), unless otherwise indicated.
      Form bent-metal corners to smallest radius possible without causing grain separation or
      otherwise impairing work.
   E. Weld corners and seams continuously to comply with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

G. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

H. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

I. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

J. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

K. Remove sharp or rough areas on exposed traffic surfaces.

L. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.10 WELDING

A. Perform welding in accord with the AWS reference standard. Use procedures such as preheat or interpass temperature as recommended by AWS standards.

B. All shop and field welding must be performed by qualified welders who hold current welding certificates.

C. Surfaces to be welded must be free of loose scale, slag, rust, grease, paint and other foreign material. Mill scale which withstands vigorous wire brushing may remain.

D. Joint surfaces must be free of fins and tears caused by shearing. Wherever practicable, prepare edges by gas cutting using a mechanically guided torch.

E. Electrodes:
   1. For structural steel, use AWS Low Hydrogen, Electrode E70XX Series suitable for the welding process used.
   2. For stainless steel, use 70 ksi minimum tensile strength filler material suitable for base metals and welding process in accordance with AWS specifications.
   3. For aluminum, use filler alloy 5356 in accordance with AWS specifications.
4. Protect electrodes from exposure to moisture and coating.

F. If shop welding is done by automatic, submerged arc process, verify that physical properties of deposited weld metal will be similar to properties of the base metal.

G. No welding shall be done when the temperature of the base metal is below 32°F.

H. The cover bead or finish pass must have a smooth, uniform surface with reinforcement of 1/16 to 1/8 inch. Surface voids, cracks in finish weldments, or undercutting of base metal at the fusion line is not acceptable.

2.11 SURFACE PREPARATION AND PAINTING

A. All surfaces shall be prepared and finished in accordance with Division 9 requirements unless otherwise noted in the Drawings. Structural steel shall be shop primed. Stainless steel shall not be coated unless otherwise specified in the Drawings or elsewhere in the Specifications.

B. Galvanize structural steel items specifically shown or specified as galvanized in the Drawings. Members that are warped during the galvanizing process will be rejected.

2.12 INSPECTION AND TESTING

A. Mill or shop inspection and non-destructive testing (in addition to field inspection and non-destructive testing) may be done by the Owner.

B. Inspection in mill, shop, or field in no way relieves the Contractor from his responsibility to furnish satisfactory materials. Right is reserved to reject material at any time before final acceptance if material and workmanship do not conform to drawings and specifications.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items according to industry specifications and codes and reviewed shop drawings.

B. Fastening to In-Place Construction:
   1. Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts and other connectors.

C. Cutting, Fitting, and Placement:
   1. Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.02 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS
   A. Install framing and supports to comply with requirements of items being supported, including Manufacturers' written instructions and requirements indicated on Shop Drawings, if any.

3.03 INSTALLING PIPE BOLLARDS
   A. Anchor bollards in place with concrete footings as shown in the Drawings. Support and brace bollards in position in footing excavations until concrete has been placed and cured.

3.04 ADJUSTING AND CLEANING
   A. Touchup Painting:
      1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA1 for touching up shop-painted surfaces. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
      2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09.
   B. Repair of Galvanized Surfaces:
      1. Thoroughly clean field welds, bolted connections, abrasions, abraded areas and galvanized surfaces damaged from welding, handling, or installation shall be repaired immediately after installation with galvanizing repair material. Apply matching galvanized repair coat as specified in this Section. Galvanizing repair shall be performed and completed before concrete is placed. Any member requiring repair of more than 2 percent of the surface area shall be rejected.

END OF SECTION
SECTION 05 53 00

METAL GRATINGS AND COVER PLATES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install metal gratings and floor cover plates along with embedded metal frames as shown on the Drawings or specified.

1.02 RELATED WORK

A. Division 03 – Concrete
B. Division 05 – Metals
C. Division 09 – Finishes

1.03 REFERENCE STANDARDS

A. International Code Council
   1. International Building Code (IBC)
B. American Society of Civil Engineers (ASCE)
   1. ASCE-7: Minimum Design Loads for Buildings and Other Structures
C. The Aluminum Association
D. American Institute of Steel Construction (AISC).
E. American Welding Society (AWS):
   1. D1.1 Structural Welding Code – Steel
   2. D1.2 Structural Welding Code – Aluminum
   3. D1.6 Structural Welding Code – Stainless
F. American Society for Testing and Materials (ASTM):

G. National Association of Architectural Metal Manufacturers (NAAMM)
3. ANSI/NAAMM MBG533 - Welding Standards For Fabrication of Steel, Stainless Steel and Aluminum Bar Grating.

1.04 SUBMITTALS

A. Shop Drawings
   1. Submit shop drawings as specified and required in the Contract Documents.
   2. Submit detailed shop drawings showing sizes of members, method of assembly, anchorage, and connection to other members for approval prior to fabrication.

B. If cover plate design and details are not shown in the Drawings, provide a letter sealed by a Licensed Professional Engineer in the State which the project will be built stating that the proposed cover plates and details have been designed and detailed under their supervision and meet all codes referenced by this Section and requirements of this Section.

C. Submit Manufacturer’s product data for gratings and cover plates including span and deflection tables and details of construction.

D. Submit Manufacturer’s installation instructions.

E. Submit samples of gratings and cover plates, if requested by the Owner’s Representative.

1.05 COORDINATION

A. The Work of this Section shall be completely coordinated with the Work of other Sections. Verify at the Site the dimensions and the Work of other trades adjoining items of Work in this Section before fabricating or installing the items specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the Work of other Sections.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect gratings and cover plates against scratching, splashes, mortar, paint and other damage during transportation, storage, installation, and until adjacent work by other trades is complete.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide products that conform to the following unless otherwise shown on the Drawings.

2.02 PERFORMANCE CRITERA

A. Grating:
1. Design Loads, choose whichever gives the greatest stresses:
   a. Pedestrian Access Only
      (i) Uniform Live Load: 125 psf
      (ii) Concentrated Live Load: 1,500 lbs
      (iii) Maximum Clear Span Deflection:
            (a) L/360 or 1/4 inch, whichever is less, under uniform loading of 100 psf.
   b. Vehicular Access
      (i) Uniform Live Load: 250 psf
      (ii) Concentrated Live Load: 16,000 lb wheel load with an impact factor of 1.33
           over a 20 inch by 10 inch tire contact area.
      (iii) Maximum Clear Span Deflection:
            (a) L/360 or 1/4 inch, whichever is less, under uniform loading of 100 psf.

2. Bar Layout:
   a. Bearing bars shall be 3/16 inches minimum spaced at a maximum of 1 3/16 inches on center.
   b. Cross bar spacing shall not exceed 4 inches on center.

B. Checkered Cover Plate:
   1. Design Loads, choose whichever gives the greatest stresses:
      a. Pedestrian Access Only
         (i) Uniform Live Load: 125 psf
         (ii) Concentrated Live Load: 1,500 lbs
         (iii) Maximum Clear Span Deflection:
               (a) L/360 or 1/4 inch, whichever is less, under uniform loading of 100 psf.
      b. Vehicular Access
         (i) Uniform Live Load: 250 psf
         (ii) Concentrated Live Load: 16,000 lb wheel load with an impact factor of 1.33
              over a 20 inch by 10 inch tire contact area.
         (iii) Maximum Clear Span Deflection:
               (a) L/360 or 1/4 inch, whichever is less, under uniform loading of 100 psf.

2.03 MATERIALS

A. Weight Limit and Lifting Requirements
   1. Provide grating and cover plates in individual pieces that do not exceed 50 lbs. in weight
      unless otherwise shown in the Drawings.
   2. Provide lifting hooks for cover plate per the Drawings. If not shown in the Drawings,
      provide lifting hooks in each corner of an individual cover plate that allows for balanced
      lifting of the plate.

B. Rectangular Bar Grating and Appurtenances
   1. General Requirements
      a. Provide grating of the material, depths, and bearing bar thicknesses as shown on the
         Drawings and as specified. If not shown on the Drawings, provide grating that meets
         the performance criteria in 2.02.
b. Grating shall be banded along edges and around openings two inches or greater in
diameter/dimension with a bar of the same depth and thickness as the bearing bars.
Bearing or cross bars shall be welded to the banding bar.
c. Embedded grating support frames shall be of the same material as the grating, unless
otherwise shown on the Drawings.
d. Attach grating to supports using sturdy 16 gauge saddle type clips and fasteners, or
approved equal.

2. Aluminum Grating
   a. Alloy 6061-T6 or 6063-T6 conforming to ASTM B221

3. Stainless Steel Grating
   a. Use the stainless steel grade indicated on the drawings (304 or 316). Where the grade
      is not specified use AISI 316. Use a weldable (304L or 316L) grade of stainless steel
      for welded items.

C. Cover Plates
   1. General Requirements
      a. Provide cover plates of the material, depths, and with stiffening members as detailed
         on the Drawings and as specified. If not detailed on the Drawings, provide cover
         plates that meet the performance criteria in 2.02.
      b. Cover plates shall be tread plate having a raised figure pattern on one surface to
         provide improved traction.

2. Steel Cover Plates
   a. Steel cover plates shall be galvanized ASTM A572, Grade 50 steel plate or ASTM
      A240 316L stainless steel plate (25 ksi min. yield strength) as called for in the
      Drawings.
   b. Frames and supports shall match the cover plate material.
   c. Fastening devices and hardware shall match the cover plate material.

3. Aluminum Cover Plates
   b. Frames and supports shall be all aluminum construction.
   c. Fastening devices and hardware shall be Type 316 stainless steel.
   d. Mill finish.

2.04 FABRICATION
   A. Provide work true to detail; with clean, straight, sharply defined profiles, and smooth surfaces
      of uniform color and texture free from defects impairing strength or durability.
   B. Field verify dimensions and support locations prior to fabrication.
   C. Provide connections and accessories of sufficient strength to safely withstand stresses and
      strains to which they will be subjected. Threaded connections shall be made so that the threads
      are concealed by fitting.
   D. Angle frames for grating and floor plates shall be mitered and welded at corners and with
      welded strap anchors or headed studs attached.
   E. Welded joints shall be rigid and continuously welded or spot welded as specified or shown.
      Dress the face of welds flush and smooth. Exposed joints shall be close fitting and located
      where least conspicuous.
F. Welding of parts shall be in compliance with the latest edition of the applicable AWS welding code. Welding only to be done where shown, specified, or permitted by the Engineer. Welding shall be done by welders certified to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

G. Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration.

H. Grating sections shall be fabricated so that longitudinal and cross bars in adjacent sections shall be in line when erected. Grating shall be furnished in reasonable size pieces, avoiding patchwork, with due regard for neat overall appearance.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that opening sizes and dimensional variations are acceptable for installation of grating or cover plates at the specified tolerances. Report any non-complying areas to the Construction manager prior to proceeding with installation.

3.02 INSTALLATION

A. Install all items furnished except items to be embedded in concrete which shall be installed under Division 3. Install items to be attached to concrete or masonry after such work is completed and in compliance with the details shown.

B. Field cutting of finished surfaces is not allowed unless specifically approved by the Engineer. When cutting is approved, use mechanical cutting tools; do not use flame cutting tools.

C. Secure grating with fastening devices as specified to prevent movement, except where removable grating is called for on Drawings.

D. Unless otherwise shown, cover plates shall be shop drilled using countersunk holes for bolting hardware. Supporting embedded framing shall be field drilled using the cover plate as a template.

E. Where aluminum contacts a dissimilar metal, field-apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

F. Where aluminum contacts masonry or concrete, field-apply a heavy brush coat of zinc chromate primer to the masonry or concrete. For embedded items, coat the embed.

G. Where aluminum contacts wood, field-apply two coats of aluminum metal and masonry paint to the wood.

3.03 FIELD QUALITY CONTROL

A. Tolerances
   1. Maximum space between adjoining or abutting sections: 1/4-inch.
   2. Maximum variation from top surface plane of adjoining or abutting sections or structure: 1/8-inch.

END OF SECTION
SECTION 06 50 00

FIBERGLASS REINFORCED PLASTICS & FABRICATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to fabricate and install FRP gratings, stairs, handrails, ladders and other structural fabrications as shown on the Drawings or as specified.

1.02 RELATED WORK

A. Division 03 – Concrete
B. Division 05 – Metals
C. Division 06 – Wood, Plastics and Composites

1.03 REFERENCE STANDARDS

A. International Code Council
   1. International Building Code (IBC)
B. American Society of Civil Engineers (ASCE)
   1. ASCE-7: Minimum Design Loads for Buildings and Other Structures
C. American Composites Manufacturers Association (ACMA)
   1. FRP Composite Fiberglass Grating Manual
D. United States Department of Labor:
   1. OHSA Regulations (Standards - 29 CFR); Part 1926 - Safety and Health Regulations for Construction.
E. American Society for Testing and Materials (ASTM):
   3. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

1.04 SUBMITTALS

A. Shop Drawings:
1. Submit shop drawings as specified and required in the Contract Documents.
2. Submit detailed shop drawings showing sizes of members, method of assembly, anchorage, and connection to other members for approval prior to fabrication.

B. Product Data:
1. Submit all Manufacturer’s product data for gratings, including span and deflection tables and details of construction.
2. Submit all Manufacturer’s product data for other FRP shapes and fabrications, including all dimensions and material properties required to review the product versus the requirements of this specification.
3. Submit certified test data based on tests of actual production samples which demonstrate that the products conforms to the stress and deflection requirements specified herein.

C. Submit documentation, in the form of a letter and/or calculations, which confirms that the performance criteria in this Section is met by the FRP products and fabrications provided. The documentation shall be signed and sealed by a Professional Engineer licensed in the State where the project is located.

D. Submit Manufacturer’s installation instructions.

E. Submit samples of gratings and other products, if requested by the Owner’s Representative.

1.05 COORDINATION
A. The Work of this Section shall be completely coordinated with the Work of other Sections. Verify at the Site the dimensions and the Work of other trades adjoining items of Work in this Section before fabricating or installing the items specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the Work of other Sections.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect gratings and other FRP products against scratching, splashes, mortar, paint and other damage during transportation, storage, installation, and until adjacent work by other trades is complete.

1.07 QUALITY ASSURANCE
A. All FRP products and fabrications shall be supplied by an experienced firm who has continually engaged in the manufacture and/or fabrication of the FRP products used on the project for a minimum of five years.

PART 2 PRODUCTS

2.01 GENERAL
A. All FRP items under this Section shall be composed of fiberglass reinforcements and resins in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Drawings and Specifications.

B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mats and/or surfacing veils in sufficient quantities as required by the application or to meet physical properties.
C. Resin shall be vinyl ester for all systems integrally resistant, without applied coatings, to ultra violet radiation, and to all chemicals present in each of the respected facilities identified in the Drawings.

D. All finished surfaces shall be smooth, resin rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

E. All FRP shall have a tested flame spread rating of 25 or less in accordance with ASTM E84.

2.02 PERFORMANCE CRITERA

A. FRP Grating & Platforms:
   1. Design Loads:
      a. Pedestrian Access Only
         (i) Uniform Live Load: 125 psf
         (ii) Concentrated Live Load: 1,500 lbs
      b. Vehicular Access
         (i) Uniform Live Load: 250 psf
         (ii) Concentrated Live Load: 16,000 lb wheel load with an impact factor of 1.33 over a 20 inch by 10 inch tire contact area.
   2. Maximum Clear Span Deflection:
      a. L/360 or 1/4 inch, whichever is less, under uniform loading of 100 psf.
   3. Bar Layout:
      a. Bearing bars shall be 3/16 inches minimum spaced at a maximum of 1 3/16 inches on center.
      b. Cross bar spacing shall not exceed 4 inches on center.

B. FRP Structural Members:
   1. Design Loads:
      a. Meet all applicable design loads and geometric requirements of the most current version of IBC, ASCE-7 and OSHA.
      b. If structural members support grating or platforms, meet the loading requirements for FRP Grating in this Section.
   2. Maximum Member Deflection:
      a. L/180 under the controlling load combination.

C. FRP Handrailings
   1. Design Loads & Geometry:
      a. Meet all applicable design loads, allowable deflections and geometric requirements of the most current version of IBC, ASCE-7 and OSHA.

D. FRP Stair Treads:
   1. Design Loads & Geometry:
      a. Meet all applicable design loads and geometric requirements of the most current version of IBC, ASCE-7 and OSHA.

E. FRP Ladders
   1. Design Loads & Geometry:
      a. Meet all applicable design loads and geometric requirements of the most current version of IBC, ASCE-7 and OSHA.
2.03 PRODUCTS & MATERIALS

A. FRP Grating
   1. Molded fiberglass using a vinyl ester resin with chemical formulations suitable for chemical exposure to all chemicals present in each of the respected facilities identified in the Drawings.
   2. Tested burn time of less than 30 seconds and an extent of burn rate less than or equal to 10 mm per ASTM D635.
   3. Color: Yellow
   4. Provide grating that meets the performance criteria in 2.02.
   5. Provide structural FRP angle frames, structural support shapes, and grit impregnated plate where required and appurtenances as shown.
   6. Provide FRP angle frames continuous around the grated openings and trenches in order to present an even and flat support for the grating except as otherwise shown. The angles and anchors shall be as per the manufacturer.
   7. Top surfaces shall have grit surface for skid resistance.
   8. Coordinate the layout of grating panels with work of other Sections to provide openings for approved mechanical equipment, operators, gates and other items which require penetrations or openings in the grating. Grating panels shall be further subdivided and supported to provide maximum panel weight of 110 lbs.
   9. Attach grating to supports using 316 SS grating clips and fasteners.

B. FRP Handrailing
   1. System shall be composed of FRP tubes; solid FRP connector plugs snugly fitting the inside dimensions of tubes; solid FRP connector rods; and flattened corrugated, 4 in high, FRP kickplates with 0.5 in deep corrugations and stainless steel drive rivets for fastening to posts. Provide FRP sleeves for removable connections to concrete and provide FRP baseplate assemblies with stainless steel fasteners for wall connections and for slab connections where shown. Provide approved epoxy cement for all tube, plug and rod connections and epoxy grout for post connections set in concrete.
   2. Fabricate with continuous posts and top rail, with intermediate rails cut between posts. Miter corners and direction changes neatly. Provide for rail expansion as required with internal plugs cemented one side and square, resin sealed, tube ends. Provide for kickplate expansion as detailed.
   3. Tested burn time of less than 30 seconds and an extent of burn rate less than or equal to 10 mm per ASTM D635.
   5. All required fasteners shall be 316 SS.

C. FRP Stair Treads
   1. Molded fiberglass using a vinyl ester resin with chemical formulations suitable for chemical exposure to all chemicals present in each of the respected facilities identified in the Drawings.
   2. Tested burn time of less than 30 seconds and an extent of burn rate less than or equal to 10 mm per ASTM D635.
   3. Top surfaces shall have grit surface for skid resistance and 1 3/4” integral bull nosing.
   4. Color: Yellow
   5. All required fasteners shall be 316 SS.
D. FRP Structural Shapes
1. Structural shapes shall be molded fiberglass using a vinyl ester resin with chemical formulations suitable for chemical exposure to all chemicals present in each of the respected facilities identified in the Drawings.
2. Shapes shall be designed by a professional engineer licensed in the State where the project is located to withstand all design loads required in the Specifications and the Drawings.
3. Utilize 316 SS fasteners, bolts and washers.
4. Tested burn time of less than 30 seconds and an extent of burn rate less than or equal to 10 mm per ASTM D635.
5. Color: Yellow.

E. FRP Ladders
1. All ladder components shall be flame retardant per ASTM E84, Class 1.
2. Ladder rungs shall be 1 inch solid round with slip-resistant quartz epoxy grit surface. Rungs shall penetrate inside wall of ladder rail tube and be countersunk into outside wall of ladder rail tube. Fully bond connection with epoxy to prevent rung rotation.
3. Ladder rails, base mount brackets, stand-off brackets and cages shall be FRP.
4. Utilize 316 SS fasteners, bolts and washers.
5. Tested burn time of less than 30 seconds and an extent of burn rate less than or equal to 10 mm per ASTM D635.

2.04 FABRICATION
A. Provide work true to detail; with clean, straight, sharply defined profiles, and smooth surfaces of uniform color and texture free from defects impairing strength or durability.
B. Field verify dimensions and support locations prior to fabrication.
C. Grating sections shall be fabricated so that longitudinal and cross bars in adjacent sections shall be in line when erected. Grating shall be furnished in reasonable size pieces, avoiding patchwork, with due regard for neat overall appearance.

PART 3 EXECUTION
3.01 INSPECTION
A. Verify that opening sizes and dimensional variations are acceptable for installation of grating at the specified tolerances. Report any non-complying areas to the Construction manager prior to proceeding with installation.

3.02 INSTALLATION
A. Install all items furnished except items to be embedded in concrete which shall be installed under Division 03. Install items to be attached to concrete or masonry after such work is completed and in compliance with the details shown.

3.03 FIELD QUALITY CONTROL
A. TOLERANCES
1. Maximum space between adjoining or abutting sections: 1/4-inch.
2. Maximum variation from top surface plane of adjoining or abutting sections or structure: 1/8-inch.

END OF SECTION
SECTION 09 96 00
HIGH PERFORMANCE COATINGS

PART I  GENERAL

1.01  SCOPE OF WORK

   A. Furnish labor, materials, equipment, and incidentals necessary to prepare surfaces and to apply high performance coatings to new equipment, pumps, piping and valves, structural steel, masonry, concrete and miscellaneous items specified in the Contract Documents.

   B. High performance coatings are special coatings to be used at specific locations or on specific surfaces as indicated herein.

   C. The term "paint" as used in this section means the high performance coatings specified herein. Painting may have been specified in other Specification Sections. All paint for concrete or metal surfaces shall be especially adapted for use around a moist and humid environment and shall be applied in conformance with the Manufacturer's published instructions.

1.02  RELATED WORK

   A. Division 01 – General Provisions

   B. Division 03 – Concrete

   C. Division 05 – Metals

   D. Division 26 – Electrical

   E. Division 40 – Process Integration

   F. Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment

   G. Division 46 – Water and Wastewater Equipment

1.03  SUBMITTALS

   A. Submit product data, shop drawings certificates and instructions on all high performance coatings items as specified herein for review in accordance with the General Conditions.

   B. Painting Schedule: Submit detailed list indicating individual items to be painted, preparation, paint manufacturer, product designation, color charts, and dry mil thickness, adhesion P.S.I., and anchor profile for each item to be painted. Submit color charts to Owner at least 60 days prior to paint application to allow time for color selection.

   C. Product Data: Submit complete data on each type and kind of paint and primer for review. Submittal data shall show where and for what uses each paint product is to be used, with cross reference made to paragraphs of the specifications or the coating schedule. Data submitted on each type and kind of paint product shall include information to show that the product meets the detailed requirements of these specifications.
D. Manufacturer's Instructions: Submit the Manufacturer's published instructions for use as a guide in specifying and applying the Manufacturer's proposed paint. Paint shall not be delivered to the job site before review of the Manufacturer's instructions by the Owner's Representative. A Manufacturer's paint will not be considered for use unless that Manufacturer's published instructions meet the following requirements:

1. The instructions must have been written and published by the Manufacturer for the purpose and with the intent of giving complete instruction for the use and application of the proposed paint in the locality and for the conditions for which the paint is specified or shown to be applied under this contract.

2. All limitations, precautions and requirements that may adversely affect the paint; that may cause unsatisfactory results after the painting application; or that may cause the paint not to serve the purpose for which it was intended, that is, to protect the covered material from corrosion, shall be clearly and completely stated in the instructions. These limitations and requirements shall include, but not be limited to, the following:
   a. Surface preparation and anchor profile
   b. Methods of application
   c. Number of coats
   d. Thickness of each coat
   e. Total thickness
   f. Drying time of each coat, including primer
   g. Drying time of final coat before placing in service
   h. Time allowed between coats
   i. Primer required to be used
   j. Primers not permitted
   k. Use of a primer
   l. Compatible topcoats
   m. Thinner and use of thinner
   n. Weather limitations during and after application (temperature, humidity, wind velocity)
   o. Mixing and thinning requirements
   p. Protection from sun
   q. Physical properties of paint, including percent solids content by volume, ingredient analysis, and weight per unit surface per dry mil thickness
   r. Cathodic disbonding limitations, if any
   s. Equipment settings (air cap, fluid tip, equipment pressure settings, etc.).

E. Panels:

1. Submit panels containing samples of proposed paints and coatings. Include three displays of each kind of paint used. Panel to be representative of material to be coated.

2. Mark panels to indicate respective types of surfaces to which several kinds and colors of paint, stain, and coating are applied.

F. Samples: If requested by Owner, submit one pint of each kind of paint or stain proposed for use. Do not deliver materials to the site until representative samples (if requested) have been approved.

G. List of five similar projects.

H. Material Safety Data Sheets (MSDS) for all coatings, solvents, sealers, and paints to be utilized.
I. Submit documentation to Owner, including disposal manifest that shows that surface preparation debris has been disposed of in accordance with the local, state, and federal regulations based on lead content at no additional cost to the Owner.

J. Applicator’s experience and qualifications. List of references substantiating the requirements as specified.

K. Documentation that QA/QC personnel are currently certified as NACE International Certified Coating Inspector Level 3 (CIP Level 3).
   1. Sample QA/QC Form.

L. Where ANSI/NSF Standard 60 and 61 approval is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.

M. Inspection Program containing the written procedures to be used to determine if the requirements of this specifications are met.

1.04 REFERENCE STANDARDS

A. Current editions of the following specialty specifications, standards, and information will be used by the Owner’s Representative, when applicable, to determine conformance with the Coating Specifications. Contractor shall adhere to all requirements listed in the following specifications and standards. If requested, electronic copies of all listed specifications and or standards shall be provided to the Owner's Representative at no additional cost.

B. National Association Of Corrosion Engineers (NACE)
   1. SP0178 - Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service
   2. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
   3. SP0274 - High-Voltage Electrical Inspection of Pipeline Coatings Prior to Installation
   4. RP0287 - Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using Replica Tape
   5. SP0892 - Linings Over Concrete for Immersion Service

C. Steel Structures Painting Council (SSPC)
   1. SSPC Good Painting Practice, Vol. 1, Chapters 2.3, "Non-Metallic Abrasives," 2.4, "Abrasive Air Blast Cleaning, and " 2.5, "Water Blast Cleaning"
   2. Paint Application (PA) PA1 - Shop, Field, and Maintenance Painting of Steel
   3. PA2 – Procedure for Determining Conformance to Dry Coating Thickness
   4. SP 1 - Solvent Cleaning
   5. SP 2 - Hand Tool Cleaning
   6. SP 3 - Power Tool Cleaning
   7. SP 8 - Pickling
   8. SP11 - Power Tool Cleaning To Bare Metal
   9. SP16 – Brush-off Blast Cleaning Non-Ferrous Metals
   10. AB 1 – Mineral and Slag Abrasive
   11. AB.2 – Cleanliness of Recycled Ferrous Metallic Abrasives
12. TU4 - Field Methods for Retrieval and Analysis of Soluble Salts on Substrates

D. Joint Surface Preparation Standards by NACE/SSPC
1. NACE No. 1/SSPC-SP5 - White Metal Blast Cleaning
2. NACE No. 2/SSPC-SP10 - Near-White Metal Blast Cleaning
3. NACE No. 3/SSPC-SP6 - Commercial Blast Cleaning
4. NACE No. 4/SSPC-SP7 - Brush-Off Blast Cleaning
5. NACE No. 5/SSPC-SP12 - Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting
6. NACE No. 6/SSPC-SP13 - Surface Preparation of Concrete
7. NACE No. 7/SSPC VIS-4 - Visual Reference for Steel Surfaces Prepared by Water Jetting
8. NACE No. 8/SSPC 14 - Industrial Blast Cleaning

E. American National Standards Institute (ANSI)
1. A250.1 - Test Procedures and, Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
2. Z535.1 - Safety Colors

F. American Society for Testing and Materials (ASTM)
3. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. A384 – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
5. A385 - Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
6. A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
8. D16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications
10. D1125 - Standard Test Methods for Electrical Conductivity and Resistivity of Water
11. D3359 - Standard Test Methods for Measuring Adhesion by Tape Test
12. D4258 – Standard Practice for Surface Cleaning Concrete for Coating
13. D4259 – Standard Practice for Abrading Concrete
14. D4260 - Standard Practice for Liquid and Gelled Acid Etching of Concrete
15. D4261 – Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating
16. D4262 – Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
17. D4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
18. D4285 - Standard Test Method for indicating Oil or Water in Compressed Air
19. D4414 - Standard Practice for Measurement of Wet Film Thickness by Notch Gages
21. D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
22. D4940 - Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
23. D5064 - Standard Practice for Conducting a Patch Test to Assess Coating Compatibility

G. American Water Works Association (AWWA)
   1. D102 - Coating Steel-Water Storage Tanks

H. Environmental protection is regulated by both the United States Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ). The relevant EPA regulations are published in the code of Federal Regulations (CFR) in Title 40 Parts 60, and 260 to 290, Solid Waste. The relevant TCEQ regulations are published in the Texas Administrative Code (TAC) in Title 30 Chapter 335 (30 TAC 335)-Industrial Solid Waste and Municipal Hazardous Waste and 30 TAC Chapter 111-Control of Air Pollution for Visible Emissions and Particulate Matter.

I. Federal Specifications
   1. MIL-P21035B - Paint, High Zinc Dust Content, Galvanizing Repair
   2. MIL-P26915C - Primer Coating, Zinc Dust Pigmented, for Steel Surfaces

J. National Fire Protection Association (NFPA)
   1. 101 - Life Safety Code

K. Occupational Health and Safety Administration (OSHA)

1.05 DEFINITION OF TERMS

A. Quality Assurance: Includes all those planned and systematic actions necessary to provide adequate confidence that a high-performance coating system will perform satisfactorily in service. Quality assurance includes quality control inspections.

B. Quality Control Inspection: Verification of the conformance (compliance) of materials and methods of application to the governing documents (Coating Specifications) in order to achieve a desired result. A quality control (QC) supervisor designated by the Contractor shall be responsible for on-job-site quality control. A field inspector will be designated by the Owner. The field inspector is not responsible or liable for the project coatings operations and or verifications (inspections).

C. Mandatory Quality Control Verifications: Mandatory inspections shall be conducted jointly by the Owner's Representative and the QC Supervisor to verify quality control of detailed parts of the work or materials to be used in the work. No work shall be initiated by the Contractor that will limit complete (100%) inspection of the Owner's Representative and QC Supervisor of items included within mandatory quality control verifications.

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D. Inspection Program: Inspection Program is the written procedures used to determine if the requirements of the specifications are met. The Inspection Program shall include mandatory quality control verifications. The Inspection Program details the information needed, controls, limiting factors, instruments, and other items necessary to confirm that the requirements of the Coating Specifications are maintained. The QC Supervisor shall maintain a daily log to verify compliance with the coating specifications. Mandatory quality control verifications included in the Inspection Program will be reviewed by the Owner's Representative. Contractor's QC Supervisor is solely responsible for verification of surface prep, mixing, application and testing of coatings for the project. The Owner assumes no responsibility or liability for requirements outlined in the specifications.

E. Inspection Schedules: Times and dates determined by the Contractor to coordinate work progress with the inspection requirements.

F. Off-Site Coating Operations: Coating operations performed anywhere other than the project site.

G. Specialty Specifications and Standards: Standards reference to recognized industry, such as those published by NACE International, Steel Structures Painting Council, American Society of Testing and Materials, or other organizations and are used as a part of the Technical Specifications.

H. Exposed Surfaces: The term "exposed surfaces" is used to define painting locations and requirements. It shall include all interior or exterior surfaces, top of walls, ceilings, and surfaces to 1'-0" below grade or the weir level or to floor level, whichever applies.

1.06 QUALITY ASSURANCE

A. All paints, sealers, and coatings to be manufactured by those firms listed in this Specification Section.

B. All coatings provided for use on this project in the field or from equipment suppliers shall comply with local, state and federal government laws, regulations, and ordinances related to items such as lead, chromate, carcinogens and volatile organic compounds.

C. Quality Control (QC) is the responsibility of the Contractor (competent superintendent). The Contractor shall designate in writing a quality control supervisor (QC Supervisor) who shall be responsible for on-job-site quality control. The QC Supervisor can be the Contractor himself or herself or can be a person designated by the Contractor.

D. The QC Supervisor shall have the following minimum qualifications:
   1. Minimum of 5 years' experience in performing and/or supervising abrasive blast cleaning operations and coating applications.
   2. Knowledge of abrasives, equipment required, and applicable safety requirements of operating equipment.
   3. Knowledge of surface preparations methods, equipment required, and applicable safety requirements of operating equipment.
   4. Knowledge of coating materials, the equipment required for their proper application, and applicable safety requirements and of operating equipment.
   5. Knowledge of calibration and proper use of test instruments.
   6. Knowledge of all work-related safety requirements and applicable safety appliances.
7. Complete understanding of the intent and application of the Specifications, Specialty Specifications and Standards.

E. Applicator's Experience: Minimum of 5 years' practical experience in application of specified products. Submit a list of recent projects and names of references for those projects with the Shop Drawing.

F. Continuity of Contractor: Coating Contractor shall coordinate with the Owner’s Representative for replacement of the field supervisor. Replacement of field supervisor will require notification and approval from Owner's Representative 72 hours in advance.

G. Services of Manufacturer's Representative: Arrange for coating manufacturer's representative to visit job site at intervals during surface preparation and application of coating for quality assurance, and to determine compliance with manufacturer's instructions and this specification section and as may be necessary to resolve field problems attributable to, or associated with, manufacturer’s products furnished under this Contract.

H. All coatings in contact with potable water shall conform to ANSI/NSF Standard 61 and shall be certified by an organization accredited by ANSI. All process, raw water, service water, potable water, and chemical piping, fittings, tanks, valves, equipment, and structures in contact with the water being treated are included in this requirement.

I. Manufacturers, suppliers and others that will supply equipment for the project shall provide the project specified coatings on their products. Owner will select final color of the equipment. Contractor is responsible for coordination with manufacturer/supplier of the equipment for the color of the equipment.

1.07 DELIVERY, HANDLING AND STORAGE

A. All coating materials shall be delivered to the job site in the manufacturer's original containers, unopened, and with labels identifying the manufacturer, the product, the batch number, and the date of manufacture. Multi-component materials shall be matched with the correct number and quantity of components for each mixed unit.

B. Coating materials shall be checked for the expiration date of shelf life. Coating materials shall not be used after the expiration date and shall be removed from the job site on or before the shelf life expires.

C. No damaged or leaking containers of material shall be used or stored with the acceptable material. Damaged containers shall be removed from the job-site. Damaged means that the container is deformed in a manner that the material cannot be removed without loss.

D. If a container of one of the components of a multi-component material is damaged or leaking, all components which make one mixed unit of that material shall be removed from the job-site.

E. All coating materials shall be stored in a manner to provide protection from temperature extremes. The minimum storage temperature shall be 55°F and the maximum storage temperature shall be 120°F, or as recommended in writing by the manufacturer's representative.

F. Store materials in an approved location which meets the manufacturer's storage requirements. Recommended storage temperatures and ventilation shall be maintained. Keep the storage area clean. Remove oily rags, waste, or other fire hazards from buildings each night; take adequate
precautions to avoid damage by fire. Place cloths and cotton waste which might constitute a fire hazard in metal containers or destroy at the end of each workday.

G. Shipping
1. Where pre-coated items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
2. Use non-metallic or padded slings and straps in handling.
3. Correct damaged items.

1.08 MAINTENANCE MATERIALS

A. At the end of the project, the Contractor shall turn over to the Owner a gallon of each type and color of paint, primer, thinner, or other coatings used in the field painting. The material shall be delivered in unopened labeled cans, just as it comes from the factory. Where multiple component materials are used, the Contractor shall supply an unopened kit of the necessary materials in the Manufacturer's smallest standard packaging size (i.e., a 2-component epoxy with a 1:1 mix ratio would require a 1-gallon can of resin and a 1-gallon can of curing agent). The Manufacturer's literature describing the materials and giving directions for their use shall be furnished in three ring binder. A typewritten inventory list shall be furnished at the time of delivery.

1.09 SUBSTITUTIONS

A. Wherever a product is designated by trade name with provision for an equal, the product specified must be used unless a written request for substitution is submitted to the Engineer for review and approval. The substitution procedure is specified in the Uniform General Conditions. The request for substitution must include the manufacturer's complete technical data sheets on the proposed product with a certified ingredients analysis signed by an officer of the manufacturer and sufficient information including applicable case history information, for making a complete comparison between specified and proposed product.

B. Consideration will be given to those which have been used successfully in water and wastewater treatment plant service for at least 10 years. The request for substitution must include a list of at least 10 applications where the product has been in continuous use for at least 5 years. Furnish the Owner's name, the Owner's Representative's telephone number and the name of the product used.

1.10 PROTECTION OF ENVIRONMENT, HEALTH AND SAFETY

A. Comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.

B. Comply with applicable federal, state, and local regulations for confined space entry.

C. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application and dust prevention including, but not limited to the following Acts, Regulations, Standards and guidelines:
1. Clean Air Act
2. National Ambient Air Quality Standard
3. Resource Conservation and Recovery Act (RCRA)
D. Provide and operate equipment that meets explosion proof requirements. Conform to applicable code for flame and smoke rating requirements for finishes.

E. Contractor is solely and completely responsible for conditions of the job site including safety of all persons (including employees) and property during performance of the work. This requirement applies continuously and is not limited to normal working hours. Conform to safety provisions of the U.S. Department of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal, state and local laws, ordinances and codes. Contractor shall comply with all safety-training requirements promulgated or required for this project.

F. In accordance with requirements set forth by regulatory agencies applicable to the construction industry and manufacturer's printed instructions and appropriate technical bulletins and manuals, the Contractor shall provide and require use of personal protective lifesaving equipment for persons working on or about the project site.

G. Head and Face Protection and Respiratory Devices: Equipment shall include protective helmets which shall be worn by all persons while in the vicinity of the work. In addition, workers engaged in or near the work site during sandblasting shall wear eye and face protection devices and air purifying, halfmask or mouthpiece respirators with appropriate filters. Barrier creams shall be used on any exposed areas of skin.

H. Ventilation: Ventilation shall be used to control potential dust and hazardous conditions within confined areas. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to non-hazardous conditions. Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Ventilation shall reduce the concentration of air contaminants to the degree a hazard does not exist. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

I. Sound Levels: Whenever the occupational noise exposure exceeds maximum allowable sound levels, the Contractor shall provide and require the use of approved ear protective devices.

J. Illumination: Adequate illumination shall be provided while work is in progress, including explosion-proof lights and electrical equipment. Whenever required by the Engineer or Owner's Representative, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes will be determined by the Engineer or Owner's Representative.

1.11 WARRANTY

A. The Contractor and coating Manufacturer shall jointly and severally warrant to the Owner and guarantee that the work performed under this section against defective workmanship and materials for a period of one (1) year commencing on the date of Final Acceptance of the Project.
B. A warranty inspection will be conducted by Owner’s Representative one month prior to expiration of the warranty period. Any defective work discovered at this date shall be corrected by the Contractor in accordance with the specifications at no additional cost to the Owner. Other corrective measures may be required during warranty period shall be performed at no additional cost to the Owner.

1.12 COATING SYSTEM COMPATIBILITY

A. Each coating system shall consist of product from only one manufacturer. Application of coatings by more than one painting contractor will not be allowed.

PART 2 PRODUCTS

2.01 MATERIAL

A. All coating materials shall meet all Federal, State, and any local governmental ordinances and regulations for limiting Volatile Organic Compounds and other hazardous contents.

B. Coating materials including primer and finish coats shall each be from a same paint manufacturer.

C. Paint shall arrive on the job ready-mixed, except for the tinting of undercoats, field catalyzed coatings, and possible thinning.

D. When thinning coating, the amount of thinner used shall not exceed the limit recommended by the Manufacturer, nor shall it cause the paint to exceed the allowable limits for VOCs. Only thinners recommended by the Manufacturers, shall be used.

2.02 COLOR SCHEDULE

A. Final color selection will be made by the Owner’s Representative from color chips submitted by the Contractor; colors selected may or may not be a Manufacturer's standard color. Submit color charts to Owner’s Representative at least 60 days prior to paint application to allow time for color selection.

B. Equipment Colors

1. Equipment shall be meant to include machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.

2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as listed below:
   a. Dangerous parts of equipment and machinery such as belt guards, chain guards etc. - OSHA Safety Orange
   b. Fire Protection equipment and apparatus, and exposed moving parts, couplings, shafts etc. – OSHA Safety Red
   c. Physical hazards in normal operating area – OSHA Safety Yellow

C. Pipe Identification Painting: Pipe Identification Painting is specified in Section 40 05 97 – Identification for Process Equipment.

D. Shop Painted Equipment: Motors, equipment, pumps, valve bodies and metal pump bases shall be shop painted.
1. Motors, equipment, pumps, pump bases and valve bodies shall be painted with color as selected by the Owner.
2. All bronze or stainless steel valve bodies shall not be painted.

2.03 TEST EQUIPMENT

A. The Owner's Representative will use, but is not limited to, the following pieces of equipment to determine film thickness and presence of flaws. The Contractor shall provide, maintain and calibrate the following equipment for the Owner's Representative's use for testing the coating system. All costs related to the testing equipment shall be borne by the Contractor. All equipment will be returned to the Contractor at the end of the project.
   1. Magnetic type dry film thickness gauge
   2. Low voltage wet sponge electrical holiday detector
   3. High voltage spark tester
   4. Tooke Gauge
   5. Testex Tape (course and extra course) Press-O-Film
   6. Moisture Meters
   7. Dial Micrometer
   8. Sling Psychrometer and Weather Tables
   9. Surface Thermometer (magnetic and Infrared)
  10. Ambient Thermometer
  11. Dolly pull-off Adhesion Tester (Dollies and Glue)
  12. NIST Calibration Standards certified by U.S. Department of Commerce

2.04 COATING SCHEDULE

A. General
   1. Coat materials as called for in the Drawings and as specified in this Section.
   2. All finished coatings on horizontal surfaces shall be non-skid, slip-resistant.
   3. DFT: Dry Film Thickness.

B. Aluminum, Stainless Steel, Galvanized Steel, FRP, Copper, or Brass: Unless specifically called for in the Drawings, or specified elsewhere only clean these surfaces, do not paint.
C. Ferrous Metal, Interior, Non-Immersed, Subject to Non-Abrasive Conditions: All interior above grade ferrous surfaces subject to dry non-abrasive conditions shall be painted in accordance to the following provisions. This includes, but is not limited to: exposed pumps, exterior of valves, pipes, motors, machinery, and miscellaneous metals such as structural steel.

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
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</thead>
<tbody>
<tr>
<td>Commercial Blast Cleaning</td>
<td>Epoxy-Polyamidoamine</td>
<td>Primer 5 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
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<tr>
<td>SSPC-SP6</td>
<td></td>
<td>Finish Coat 5 mils</td>
<td>• Carboline, Carboguard 893 Polyamide Epoxy</td>
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<td>• Devoe, Devran 224V</td>
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<td>• Sherwin-Williams, MacroPoxy 646 PW</td>
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<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
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<td>• Carboline, 890 Epoxy</td>
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<td>• Devoe, Devran 224V</td>
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<td>• Sherwin-Williams, MacroPoxy 646 PW</td>
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D. Ferrous Metal, Exterior, Non-Immersed, Subject to Non-Abrasive Conditions: All exterior ferrous surfaces not submerged, and subject to non-abrasive conditions shall be painted in accordance to the following provisions. This includes but is not limited to: Exterior of non-submerged equipment, valves, pipes, pipe sleeves, brackets, grates, structural steel, light poles, exterior face of overhead doors, etc. Surfaces intermittently or partially submerged shall be treated as submerged.

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<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
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<tbody>
<tr>
<td>Commercial Blast Cleaning</td>
<td>Aliphatic-Polyurethane</td>
<td>Primer 4 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
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<td>SSPC-SP6</td>
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<td>Intermediate Coat 3 mils</td>
<td>• Carboline, 890 Epoxy</td>
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<td>• Devoe, Devran 224V</td>
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<td>Finish Coat 4 mils</td>
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<td>• Tnemec, Series 1074 Endura-Shield</td>
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<td>• Carboline, 134 HS</td>
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<td>• Devoe, Devthane 379 Series</td>
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<td>• Sherwin-Williams, HI-Solids Polyurethane</td>
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</table>
E. Ferrous Metals, Immersed or Subject to Abrasive Conditions: All ferrous surfaces below grade level, submerged, or subject to abrasive conditions shall be painted in accordance with the following provisions. This includes but is not limited to: Ladders, grates, checkered plates, handrails, access covers, exterior of submerged valves, piping, brackets, structural steel, sluice gates, roller gates, drains, etc. (surfaces that are questionable as to if they are subject to submerged or abrasive conditions shall be considered as subject to those conditions)

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<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
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<tbody>
<tr>
<td>Near White Metal Blast Cleaning, SSPC-SP10</td>
<td>Epoxy-Polyamide</td>
<td>Primer 5 mils</td>
<td>• Tnemec, Series N140 Pota-Pox Plus</td>
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<td>Finish Coat 5 mils</td>
<td>• Carboline, Carboguard 891 VOC</td>
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<td>• Devoe, Bar-Rust 233H</td>
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<td>• Sherwin-Williams, MacroPoxy 646 PW</td>
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<td>• Tnemec, Series N140 Pota-Pox Plus</td>
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<td>• Carboline, Carboguard 891 VOC</td>
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<td>• Devoe, Bar-Rust 233H</td>
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<td>• Sherwin-Williams, MacroPoxy 646 PW</td>
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F. Aluminum and Stainless Steel embedded in Concrete or Masonry, or Aluminum in Contact with Concrete or Masonry or in Contact with Dissimilar Materials and not below Water: Aluminum and stainless steel shall not require painting unless embedded in concrete or masonry or aluminum is in contact with concrete or masonry or in contact with dissimilar material or specified elsewhere shall be painted in accordance with following provisions.

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<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
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</thead>
<tbody>
<tr>
<td>As Recommended by Manufacturer</td>
<td>Polyamide-Epoxy</td>
<td>Primer not required</td>
<td>• Tnemec, 66-High Build Epoxoline</td>
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<td>Finish Coats-2 Coats @4-6 mils each</td>
<td>• Devoe Bar-Rust 235</td>
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</tbody>
</table>

G. Non Ferrous Metal Interior: All non-ferrous surfaces where painting is required shall be painted in accordance with the following provisions. This includes but is not limited to: galvanized steel, cast or ductile iron pipe supports, underside of roof decks and service doors.

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
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</thead>
<tbody>
<tr>
<td>Brush-off Blast Cleaning SSPC-SP16</td>
<td>Epoxy-Polyamidoamine</td>
<td>Primer 4 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
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<td>Finish Coat 5 mils</td>
<td>• Devoe, Devran 224V</td>
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<td>• Sherwin-Williams, MacroPoxy 646 PW</td>
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H. Non Ferrous Metal Exterior: All non-ferrous surfaces located outside and where painting is required shall be painted in accordance with the following provisions. This includes but is not limited to: galvanized steel, cast or ductile iron pipe supports, underside of roof decks and service doors.

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<tr>
<th>Surface Preparation</th>
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<th>Min. DFT</th>
<th>Manufacturers</th>
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<tbody>
<tr>
<td>Commercial Blast Cleaning</td>
<td>Epoxy-Polyamidoamine</td>
<td>Primer 4 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
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<tr>
<td>SSPC-SP16 or As Recommended by</td>
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<td>Intermediate Coat 5 mils</td>
<td>• Devoe, Devran 205</td>
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<td>Manufacturer</td>
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<td>• Sherwin-Williams, MacroPoxy 646 PW</td>
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<td>Finish Coat 3 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
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<td>• Sherwin-Williams, MacroPoxy 646 PW</td>
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<td>• Tnemec, Series 750 Endura-Shield</td>
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<td>• Devoe, Devthane 359 or 379 Series</td>
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<td>• Sherwin-Williams, Hi-Solids Polyurethane</td>
</tr>
</tbody>
</table>

I. PVC Pipe Interior: Exposed PVC pipes located inside the building carrying chemicals shall be painted as follows to comply with TCEQ's 290.42 (d) (13) for color coding requirements. The color of the exposed pipes carrying chemicals are specified in Section 40 05 97 – Identification for Process Equipment.

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Recommended by Manufacturer</td>
<td>Epoxy-Polyamidoamine</td>
<td>Primer 2 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devran 201H (2-3 mils)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Tnemec, N69-High-Build Epoxoline II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Finish Coat 3 mils</td>
<td>• Devoe Bar-Rust 235 (7-8 mils)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

J. PVC Pipe Exterior: Exposed PVC pipes located outside the building carrying chemicals shall be painted as follows to comply with TCEQ's 290.42 (d) (13) for color coding requirements. The
color of the exposed pipes carrying chemicals are specified in Section 40 05 97 – Identification for Process Equipment.

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Recommended by Manufacturer</td>
<td>Epoxy-Polyurethane</td>
<td>Primer 3 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devran 201H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Finish Coat 4 mils</td>
<td>• Tnemec, Series 1074 Endura-Shield</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devthane 359 or 379 Series</td>
</tr>
</tbody>
</table>

K. Exterior Concrete and Dense CMU-Exposed: All exterior pre-cast, cast-in-place concrete except that comes in contact with product water or chemicals and dense CMU blocks shall be painted as follows:

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Recommended by Manufacturer and SSPC-SP13</td>
<td>Modified Waterborne Acrylate</td>
<td>Primer 6 mils</td>
<td>• Tnemec, Series 156 Enviro-Crete</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe Tru-Glaze WB 4015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Finish Coat 6 mils</td>
<td>• Tnemec Series 45 H-413</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devcryl 1440 or 1449</td>
</tr>
</tbody>
</table>

L. Exterior Dense Concrete-Below Grade or Immersion: All below grade or immersed in water precast and concrete structures shall be painted as follows:

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Recommended by Manufacturer and SSPC-SP13</td>
<td>Coal Tar Epoxy</td>
<td>Finish Coat 18 mils</td>
<td>• Tnemec Series 46H-413</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe DevTar 5A</td>
</tr>
</tbody>
</table>

M. Interior Concrete and Dense CMU-Exposed

<table>
<thead>
<tr>
<th>Surface Preparation</th>
<th>Coating</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Recommended by Manufacturer and SSPC-SP13</td>
<td>Epoxy</td>
<td>Primer 5 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devran 224V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Finish Coat 5 mils</td>
<td>• Tnemec, Series N69 Hi-Build Epoxoline II</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devran 224V</td>
</tr>
</tbody>
</table>

N. Porous CMU and Concrete-Exterior Exposed except for Concrete that comes in contact with product water or chemicals, porous CMU block wall and concrete walls of exposed exterior structures shall be painted as follows:
### Surface Preparation

<table>
<thead>
<tr>
<th>Concrete SSPC-SP13, CMU Clean and Dry</th>
<th>Acrylic</th>
<th>Primer</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate Coat 5 mils</td>
<td></td>
<td></td>
<td></td>
<td>• Tnemec, Series 130 Envirofill -DFT 60-80 sq. ft/gallon</td>
</tr>
<tr>
<td>Finish Coat 6 mils</td>
<td></td>
<td></td>
<td></td>
<td>• Devoe Tru-Glaze WB 4015</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Tnemec, Series 156 Enviro-Crete</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devcryl 1440 or 1449</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Tnemec, Series 156 Enviro-Crete</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Devoe Devcryl 1440 or 1449</td>
</tr>
</tbody>
</table>

O. Porous CMU and Concrete-Interior Exposed except for Concrete that comes in contact with chemicals

### Surface Preparation

<table>
<thead>
<tr>
<th>Concrete SSPC-SP13, CMU Clean and Dry</th>
<th>Acrylic-Epoxy</th>
<th>Primer</th>
<th>Min. DFT</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate Coat 5 mils</td>
<td></td>
<td></td>
<td></td>
<td>• Tnemec, Series 130 Envirofill -DFT 60-80 sq. ft/gallon</td>
</tr>
<tr>
<td>Finish Coat 5 mils</td>
<td></td>
<td></td>
<td></td>
<td>• Devoe Tru-Glaze WB 4015</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Tnemec, Series 113 Tufcoat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Devoe Tru-Glaze WB 4438</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Tnemec, Series 113 Tufcoat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Devoe Tru-Glaze WB 4438</td>
</tr>
</tbody>
</table>

### PART 3 EXECUTION

3.01 WORK CONDITIONS

A. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 50°F above the dew point of the ambient air.

B. Surface: If surfaces to be painted cannot be put in proper condition for painting per SSPC Specification, notify Owner’s Representative in writing or assume the responsibility for and rectify any unsatisfactory finish resulting from application to an unsatisfactory surface. Do not proceed with surface preparation or coating application until adverse conditions are corrected to provide an acceptable surface. Do not apply paint to a wet or damp surface.

C. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere when surface preparation work is located within enclosures or confined areas with electrical equipment, motors, instrumentation, or other equipment that may be damaged by airborne dust and particles.

D. Do not apply coating when:
   1. Surface or ambient temperature exceeds the maximum or minimum temperatures recommended by the coating manufacturer or these specifications.
   2. When it is expected that surface temperatures will drop below 5°F above dew point within 8 hours after application of coating.
   3. Whenever the relative humidity exceeds 85% or the maximum recommended by the coating manufacturer.
4. In dust, smoke-laden atmosphere, damp or humid weather, or under conditions which could cause icing to form on the metal surface.

E. The manufacturer's recommended procedures are intended to define optimum conditions for use and performance of their products. All materials shall be used in accordance with the manufacturer's recommended procedures unless otherwise specified.

F. Equipment: The Contractor's coating and painting equipment shall be designed for application of the materials specified and shall be maintained in good working order comparable to that described in printed instructions of the coating manufacturer. Clean equipment thoroughly before and after use with the appropriate cleaning solution indicated by the coating manufacturer. All gauges and controls on spray equipment shall be in proper working order at all times and the gauges must be operational and readable.

G. Warnings: Display caution signs in necessary areas advising of spray painting and warning against open flames.

H. Barriers: Provide barriers or shelters on windy days to protect equipment and treatment facilities.

3.02 DEHUMIDIFICATION

A. Where weather conditions or project requirements dictate, provide and operate dehumidification and appropriate ventilation equipment to maintain environmental conditions suitable for abrasive blasting and coating application as specified herein and accordance with the manufacturer's published instructions and product data sheets.

B. Provide dehumidification equipment sized to maintain dew point temperature 17° or more below surface temperature of metal surfaces to be cleaned and coated. Provide system capable for providing air flows as required to maintain positive pressure and ventilation within the environmentally controlled areas. Environmentally controlled work areas shall meet the following requirements:
   1. Minimum two air exchanges per hour.
   2. Personnel Exposure Limits (PEL) at 50% of OSHA PEL limits for all chemical used in the performance of the work.
   3. Lower Explosive Limits (LEL) to be less than 50% of the most volatile solvent used in the performance of the work.

C. Dehumidification and ventilation equipment, type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment and its operation based on project requirements and anticipated seasonal weather conditions, for the project schedule.

D. Dehumidification subcontractor shall either operate the equipment or provide training to the Contractor on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8 hour days to insure proper operation of the equipment, achievement of desired environmental control, and to ensure Contractor can properly setup, operate, monitor, and maintain the equipment.

E. Operate dehumidification and ventilation equipment in a manner that prevents condensation or icing throughout surface preparation and coating application and cure.
F. Monitor ambient temperature, humidity, dew point temperature, and surface temperature both outdoors and within work area at the start, midpoint, and end of each work shift at a minimum, but not greater than 5 hours between measurements.

G. Document in writing daily environmental condition monitoring and maintenance of the equipment. Post documentation near the equipment for review by the Owner’s Representative.

3.03 ITEMS NOT REQUIRING PAINTING

A. Unless otherwise stated herein or shown on Drawings, the following items will not require painting:
   1. Corrosion-resistant ferrous alloys such as brass, bronze, or copper except where:
      a. Color coding of equipment and piping is required.
   2. Glass, PVC, FRP except as required for architectural painting or color coding.
   3. Prefinished electrical and architectural items such as motor control centers, switchgear, panelboards, transformers, switches, acoustical tile, cabinets, elevators, louvers, wall panels etc.; color coding of equipment is required.
   4. Non-submerged electrical conduits attached to unpainted concrete surfaces.
   5. Cathodic protection anodes.
   6. Items specified to be galvanized after fabrication unless specifically required elsewhere or subject to immersion.
   7. Insulated piping and/or piping with jacket will not require exterior coating, except as required for architectural painting or color coding.
   8. Nameplates or serial numbers.
   10. Valve operator stems.
   11. Existing and new corrugated metal wall panels.

3.04 SURFACE PREPARATION

A. Substrate surfaces shall be prepared in accordance with this Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied. Where conflicts occur between the manufacturer’s recommendations and these specifications, the more stringent requirements of the two shall apply. The Steel Structures Painting Council, Surface Preparation Specification for steel shall be used as a guide for concrete.

B. Provide Engineer and Owner’s Representative minimum 5 working days advance notice prior to start of surface preparation work or coating application work.
   1. Perform such work only in the presence of Engineer, unless Engineer grants prior written permission to perform such work in absence of Engineer.

C. Profile depth of blasted surfaces shall be not less than 1 mil or greater than 2 mil unless required otherwise by coating manufacturer.

D. Metal Surfaces
   1. Metal surface preparation shall meet the current Steel Structures Painting Council (SSPC) as referenced in Part 1 of this Section.
      a. Wherever the words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, or blast cleaning, or similar words of equal intent are used in these specifications or in paint
manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed in Part 1 of this Specification Section.

b. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, vacublast methods may be required. Wet abrasive blasting will be allowed only when acceptable to the Engineer and per the coating manufacturer's recommendations for wet blast additives and first coat application.

c. Areas that cannot be cleaned by power tool, shall be cleaned by hand tool.

2. Weld Areas
   a. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead. Remove weld splatter and rough edges and grind rough welds so that all surfaces are in proper condition, in the opinion of the Owner's Representative, to receive the specified coating.
   b. Prepare weld area that there is:
      (i) No weld splatter on adjacent to the weld or any other area to be painted.
      (ii) No sharp peaks or ridges along the weld bead.
      (iii) No undercutting or reverse ridges on the weld bead.

3. Pre-Blast Cleaning Requirements
   a. Prior to blast cleaning, remove oil, grease, welding fluxes, and other surface contaminants, such as markings or stickers. Use appropriate solvents that will not harm in accordance with SSPC SP1.
   b. Use steam, open flame, hot water, or cold water with appropriate detergent additives followed by clean water rinsing for cleaning.
   c. Clean small isolated areas as above or solvent cleaned with suitable solvents and clean cloths.
   d. Round or chamfered all sharp edges and grind smooth burrs, jagged edges, and surface defects.

4. Blast Cleaning Requirements
   a. General
      (i) Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.
      (ii) Do not use abrasive, unless abrasive is a recyclable abrasive.
      (iii) Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
   b. Shop Blasting
      (i) Notify Engineer at least 5 working days prior to start of shop blast cleaning to allow for observation of the work during surface preparation and shop application of paints. Work shall be subject to the Engineer’s acceptance before shipment to the jobsite.
      (ii) Structural steel, metal doors and frames, metal louvers, and similar items may be shop prepared and primed.
   c. Field Blasting
      (i) Perform sand blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures shall meet requirements of Steel Structures Painting Council.
(ii) Field blasting in areas with electrical or mechanical equipment, or within buildings shall be performed with dustless abrasive systems such as Sponge-Jet, dry ice abrasive blasting.

5. Post-Blast Cleaning and Other Cleaning Requirements
   a. Clean surfaces of dust and residual particles from cleaning operations by dry air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.
   b. Paint surfaces the same day they are sandblasted. Re-blast surfaces that have started to rust before they are painted.

6. Brush-Off Blast Cleaning
   a. Equipment, procedure, and degree of cleaning shall meet SSPC-SP7, Brush-off Blast Cleaning.
   b. Use either conventional abrasive blasting with sand, grit, or nut shells or specialized abrasive blasting, such as dry ice or “Sponge-Jet” technologies. Abrasive shall be 60 mesh grit, maximum.
   c. Select various surface preparation parameters such as size and hardness of the abrasive, nozzle size, air pressure, and nozzle distance from the surface such that the surface is cleaned without pitting, chipping, or exposure of metal substrate.
   d. Prepare a trial area that is not exposed to view to verify selection of parameter. This trial area shall be used as a representative to compare blast cleaned areas acceptance.
   e. Surface profile shall have the appearance of 100 grit sandpaper with no exposed metal substrate.
   f. Repair or replace coated surfaces damaged by blast cleaning where damage is defined as visible metal substrate. If less than 5 percent of prepared surface has the metal substrate visible, the coating shall be repaired by application of a brush applied coat. If greater than 5 percent, the coating shall be completely removed to meet the specified surface cleanliness.

E. Solvent Cleaning: Remove oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action, in accordance with Steel Structures Painting Council Surface Protection Specifications (SSPC) SP1. Care shall be taken to not allow solvent chemicals to enter treatment processes.

F. Power Tool Cleaning: Subject to review by the Engineer or Owner’s Representative, any metalwork in which SP-6 or SP-10 blasting cannot be accomplished shall be cleaned in accordance with SSPC SP-3, Power Tool Cleaning, removing loose mill scale, loose rust, loose paint and other foreign matter. Pumps, motors and similar equipment to be painted shall be prepared per SSPC-SP3.

G. Unknown or Non-compatible Materials: Items coated with an unknown paint system, or a primer or system which is not compatible with the specified system, shall be blast cleaned and recoated with the specified coating system at the job site. When blasting is not feasible, the Contractor shall notify the Owner’s Representative and request permission to apply a barrier coat over the unknown or non-compatible material. The proposed barrier coat shall be recommended in writing by the paint system manufacturer and is subject to review by the Owner’s Representative. Following application of the barrier coat, if permitted, the specified coating system shall be applied. Minimum dry film thickness shall be increased an amount equal to the barrier coat and unknown or non-compatible coats.
H. Concrete Surfaces
   1. Fill all air voids or bug holes with material recommended by coating manufacturer prior to coating concrete surfaces.
   2. Allow concrete to cure for 28 days prior to coating.
   3. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC SP13, Surface Preparation of Concrete.
   4. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.

I. Plastic Surfaces
   1. Hand sand plastic surfaces to be coated with a medium grit sandpaper to provide tooth for coating system.
   2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so the surface is roughened without excessive removal of material.

J. Wood Surfaces: Prior to coating wood surfaces, fill all nail holes, cracks, open joints and other defects with putty. Tint putty to match finish color. Sand smooth after putty dries.

K. Gypsum Wallboard: Fill all cracks, holes, and other defects with compound. Sand smooth after compound dries.

L. Existing coated or Shop Primed Surfaces
   1. General
      a. Schedule with Engineer and Owner’s Representative in advance for shop primed or factory-finished items delivered to jobsite for compliance with these Specifications. Shop primed or coated surfaces shall be reviewed with the Engineer to determine if the extent of damage to the coating and suitability of finish coats to adhere to shop applied coats.
      b. If cured epoxy, polyurethane, or plural-component material is to be top coated, brush-off blast to a degree with zero-gloss, frosted visual appearance as specified herein or as recommended by the existing coating manufacturer.
      c. Surface preparation recommendations of coating manufacturer shall be subject to acceptance of the Engineer.
   2. To be Recoated or Final Coated
      a. Detergent wash and fresh water rinse.
      b. Perform touch-up repairs of existing coating.
      c. Asphalitic varnish coated ductile iron pipe will require an application of a seal coat prior to the application of cosmetic finish coat.
   3. Touch-up Repairs
      a. Clean loose, abraded, or damaged coatings to substrate by power tool to bare metal, SP11.
      b. Feather surrounding intact coating.
      c. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
      d. Apply one full finish coat of the specified primer or finish coat(s) overall.
   4. Application of Cosmetic Coat
      a. The exact nature of shop-applied coatings is not known in all cases.
      b. Check compatibility by application to a small area prior to starting the coating.
      c. If lifting or other problem occur, request disposition from the Engineer.
3.05 PROTECTION

A. Protect floors and all other areas where work is performed, with suitable drop cloths.

B. Protect surfaces and installations requiring no painting or finishing by removing, using drop cloths, masking or other approved precautionary measures. Repair or replace property and work of other trades damaged, marred or stained by painting and finishing operations.

C. Prior to surface preparation and painting operations, remove, mask or otherwise protect hardware, hardware accessories, machined surfaces, plates, light fixtures and similar items not to be painted but which are in contact with painted surfaces.

D. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors to prevent paint and other materials from entering motors.

E. Protect spaces used for mixing or storage of paint materials from damage or staining. Leave space in clean, neat condition.

F. Remove any and all overspray. If removal is not acceptable to Owner’s Representative, Contractor will be responsible for replacing item at no additional cost to the Owner.

G. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted are the responsibility of the Contractor.

3.06 PAINT MIXING

A. Multiple-Component Coatings
   1. Prepare using all of the contents of the container for each component as packaged by the paint manufacturer.
   2. No partial batches will be permitted.
   3. Do not use multiple-components coatings that have been mixed beyond their pot life.
   4. Furnish small quantity kits for touchup painting and for painting other small areas.
   5. Mix only components specified and furnished by the paint manufacturer using pre-mixed and pre-measured amounts. Mixing shall only be performed in presence of NACE Coating Inspector Level III.
   6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
   7. Fast set or plural component products shall be applied using an appropriate multipart pump that properly mixes both components at the recommended ratio using equipment recommended by the coating manufacturer. Hot mixing of fast set or plural component products will not be permitted.

B. Keep paint materials sealed when not in use and provide nitrogen blanket on fast set, plural, or moisture cured coatings on opened product containers when stored or not in use more than 8 hours.

C. Where more than one coat of material is applied within a given system, alternate color to provide a visual reference the required number of coats have been applied.
3.07 COATING APPLICATION

A. General

1. Prior to application of coating, schedule an observation by Owner’s Field Representative to verify the prepared surfaces.

2. Coating or painting shall be applied as per Manufacturer’s recommendations.

3. Comply with these specifications and printed recommendations of the paint Manufacturer in regard to drying time for each coat, technique of spray application, ventilation, paint thinning, and safety precautions. The Contractor shall fully inform all members of his field crew of these recommendations. In case of conflict, between these specifications and manufacturer’s printed recommendations, more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied coat. If recoat time limits have expired, re-prepare surface in accordance with written requirements by coating manufacturer’s technical manager. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.

4. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.

5. Keep paint materials sealed when not in use.

6. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

7. Remove blasting grit and dust from the surface to be painted before paint application begins.

8. Dust, dirt, oil, grease, or any foreign matter that will affect the adhesion or durability of the finish must be removed prior to application of the coating.

9. Coat areas with a uniform film, free of sags, runs, or brush marks. Finished surfaces must be free from runs, drips, ridges, waves, laps, brush marks and variations in color, texture and finish.

10. Where inspection shows that the specified thickness is not developed, apply additional coats in accordance with the Manufacturer’s surface preparation and cure schedule requirements to produce the required film thickness.

11. Shop Primed or Factory Finished Surfaces

   a. Power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer. Carefully blend repaired areas into the original finish.

   b. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply each coat to a uniform finish acceptable to Owner’s Representative.
B. Film Thickness, Coverage and Number of Coats
   1. Film Thickness
      a. Film thickness per coat shall be applied at the specified coating thickness or the manufacturer’s recommended minimum thickness, whichever is greater.
      b. Maximum film thickness per coat shall not exceed the coating manufacturer’s recommendations.
   2. Coverage: Coverage is specified as either total minimum dry film thickness in mils or the spreading rate in square feet per gallon.
   3. Number of Coats
      a. Apply specified number of coats, minimum without regard to coating thickness.
      b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturer’s products, and atmospheric conditions.

C. Porous Surfaces, Such as Concrete and Masonry
   1. Prime Coat
      a. May be thinned to provide maximum penetration and adhesion.
      b. Thinning of prime coat is not acceptable, if the coating material is 100% Solids.
      c. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
      d. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. Damaged Coatings, Pinholes and Holidays
   1. Feather edges and repair in accordance with the recommendations of the paint manufacturer.
   2. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by the coating manufacturer.
   3. Apply finish coats, including touchup and damage-repair coats in manner that will present a uniform texture and color-matched appearance.

E. Unsatisfactory Application
   1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and film thickness. Obtain specific surface preparation information from the coating manufacturer.
   2. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications.
   3. Repair defects in coating system per written recommendations of coating manufacturer.
   4. Evidence of runs, sags, bridges, shinners, laps or other imperfections shall be cause for rejection.
   5. Leave all staging in place until Owner’s Representative has inspected surface or coating. Replace staging removed prior to inspection and approval by Owner’s Representative.

3.08 INSPECTION AND TESTING

A. Inspection
   1. The Contractor shall provide OSHA-approved staging, scaffolding and lighting as required to permit proper inspection as outlined in these specifications.
2. Contractor shall be responsible for and shall bear all the costs to perform the quality control tests for the coating. Contractor shall record all results of testing. Forms to be filled out accurately and completely. Original copy shall be turned in daily to the Owner’s Representative.

3. Give minimum of 5 working days advance notice prior to start of surface preparation or coating application so that the Engineer and Owner’s Representative can perform the following inspections:
   a. Examination and approval of surface preparation prior to any coating.
   b. Examination and approval of each coat prior to application of the next coat.
   c. Inspection of the completed coating for runs, overspray, roughness, and any evidence of improper application.

4. Inspection by the Engineer and Owner’s Representative, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve the Contractor of responsibility to perform the work in accordance with these specifications.

5. Should any coating system fail to pass a test, the Contractor shall make necessary changes approved by the Engineer, paint Manufacturer’s Representative and Owner’s Representative for the corrective measures. The coating system will then be retested.

6. All coating tests will be performed using properly calibrated instruments.

B. Testing

1. Dry Film Thickness Testing
   a. Owner’s Representative and Engineer will conduct coating dry film thickness tests of coating as necessary and without limitation.
   b. Coating thickness will be measured with an electronic type dry film thickness gauge.
   c. Each coat will be checked for correct mil thickness. Measurements will be made no earlier than 8 hours after application of the coating.
   d. Tests for concrete coating thickness will be measured with a Tooke Gauge, a destructive test, or non-destructive ultrasonic dry film thickness gauge suitable for concrete surfaces.

2. Coating Continuity (Holiday) Testing
   a. Test finish coat, except zinc primers, using high voltage holiday tester in accordance with NACE SP0188. Test voltage shall be based on applied coating thickness.
   b. Holiday detection on pipe coatings for buried application will be performed with a high voltage tester in accordance with NACE SP0274.
   c. Holiday testing on concrete surfaces shall be performed with a high voltage holiday tester with test voltage based on base voltage between uncoated concrete and ground plus the voltage required for the coating thickness.
   d. Low voltage discontinuity testing of coatings less than 20 mils DFT will be allowed, where acceptable to the Engineer, and will be subject to the following additional requirements:
      (i) Discontinuity testing shall be performed in accordance with NACE SP0188.
      (ii) Coatings over 8 mils DFT shall be tested using the recommended low-sudsing wetting agent per NACE SP0188. Wetting agent to be removed per NACE SP0188.
      (iii) All discontinuities detected shall be surface prepared in accordance with “Existing Coating Surfaces, Touch-up Repairs”, this section, to remove all water contamination from the substrate.
C. Warranty Inspection: Warranty inspection will be conducted by Owner’s Representative during the eleventh month following completion of all coating and painting work. Contractor shall repair all defective work in accordance with this specification and to the satisfaction of the Engineer and Owner’s Representative.

3.09 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

B. Remove staging and scaffolding upon completion of the work. Remove grit, containers and rubbish from the site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job area clean and acceptable to Owner’s Representative.

D. At the completion of the project, all areas used by the Contractor shall be restored to original or better condition.

END OF SECTION
SECTION 13 34 24

PREFABRICATED CHEMICAL STORAGE ENCLOSURES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. A factory-built prefabricated chemical storage enclosure shall be supplied in accordance with project plans and specifications. The enclosure shall be molded fiberglass construction, factory pre-assembled to make a bonded unit with no external seams or joint covers. The enclosure shall house sodium hypochlorite drums and/or totes, the metering pump system, and shall have adequate space to operate/maintain the pumps/appurtenances. The Enclosure Manufacturer shall provide all lifting cables and hardware needed to off-load and set the enclosure.

1.02 RELATED WORK

A. Drawings and all provisions of the Contract Documents shall apply to this Section.

B. Electrical requirements included in Division 26.

1.03 SUBMITTALS

A. Submit to the Engineer in accordance with the General Uniform Conditions, shop drawings and product data. Submittals shall include, but not be limited to the following:

1. Certificate of Compliance or complete list of all deviations from the drawings and specifications.
2. Complete fabrication, assembly, and installation drawings, showing the Manufacturer’s dimensions, weights, and loadings, and descriptive information in sufficient detail to show the kind, size, weight, arrangements, operation, component materials and devices, external connections, anchorages and supports required, performance characteristics, and dimensions needed for installation.
3. Detailed specifications and data covering materials used, parts, and other accessories forming a part of the equipment furnished will be submitted for review.
4. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.
5. Manufacturer’s installation instruction and certification.
6. Operation and maintenance manual (as required).
7. Manufacturer’s warranty agreement in compliance with the Contract Documents.
8. Electrical data including control wiring. Electrical/pneumatic requirements, schematic diagrams, and details of components including enclosures.
9. Complete motor data.

B. Shop drawings shall be submitted in accordance with the requirements of the project showing dimensions, sizes, thickness, materials, finishes and methods of assembly. Submit Manufacturer’s technical data for all enclosure hardware and equipment. All work shall be fabricated and erected in accordance with the Manufacturer’s drawings.
1.04 QUALITY ASSURANCE

A. The Prefabricated Chemical Storage Enclosure Manufacturer shall have a minimum of five (5) years experience in enclosure fabrication. In addition, the Manufacturer shall have made no less than ten (10) enclosures similar to the one on this project. Evidence must be submitted to verify that these requirements are met prior to being deemed an acceptable manufacturer.

B. The Engineer shall have the right to inspect or test any materials during fabrication in the factory. At the option of the Engineer, certified tests of materials may be accepted in lieu of field tests.

C. The enclosure shall be manufactured by Associated Fiberglass Enterprises, U.S. Chemical Storage, or Kenco Plastics Company.

1.05 DESIGN CRITERIA

A. Structural design calculations for the enclosure shall be prepared and sealed by a professional Engineer licensed in the state of Texas, and shall be submitted for the Owner’s records as record drawings.

B. The fiberglass laminate shall consist of polyester resin sheets placed over a wood or steel structural frame, insulated with polyurethane foam. The minimum physical properties shall be:
   1. Tensile Strength: 14,000 psi (ASTM D638)
   2. Flexural Strength: 25,000 psi (ASTM D790)
   3. Flexural Modulus: 1,000,000 psi (ASTM D790)
   4. Thermal conductivity maximum 0.14 BTU/hr/ft²/F/in
   5. Minimum R value 10.9 with maximum U value 0.092

C. The enclosure shall be designed to withstand wind and snow loads appropriate for the project location in accordance with the Universal Building Code (UBC).

D. The building shall have an 8’ minimum ceiling height and doors of 6’-8” minimum height.

E. The enclosure shall have a fiberglass grated floor throughout and shall have at least 400 gallons of spill containment capacity built into the floor beneath the grating. The fiberglass grating over the sump area may be supported on corrosion-resistant pedestals, on corrosion-resistant cross-beams, or a combination of the two, at the manufacturer’s discretion. Grating and support systems inside this building shall be capable of supporting multiple 55-gallon drums (not stacked) of sodium hypochlorite, pallet-supported tote containers of sodium hypochlorite (full totes may weigh up to 3000 pounds), and incidental personnel traffic. Grating inside this building shall be designed for a 500 PSF live-load to accommodate chemical storage containers, and otherwise shall meet all applicable requirements of Section 06 50 00. Contractor shall coordinate with Enclosure Manufacturer to provide recommendation on mounting pump skid, piping supports, eyewash/shower and appurtenances.

F. The enclosure shall be entirely factory assembled and shipped as a 1-piece unit.

G. The roof of the enclosure shall be sloped to facilitate rain runoff. The enclosure shall be equipped with rain shields over the doors.
H. Openings shall be provided in walls for electrical conduits, service water, and for the outgoing sodium hypochlorite pipeline. A connection from the containment sump shall be provided for connection to a 3" PVC valved drain.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling shall be in full accordance with manufacturer’s instructions.

1.07 WARRANTY

A. The manufacturer shall provide an all-inclusive one year warranty from the date of successful start-up and Owner acceptance. The warranty shall include normal wear and tear parts. All materials equipment and workmanship shall be free from defects in material or workmanship.

PART 2 PRODUCTS

2.01 FIBERGLASS REINFORCED PLASTIC (FRP)

A. All building materials shall be compatible with sodium hypochlorite. Adequate corrosion-resistant coatings shall be provided on all metal surfaces. All hardware shall be 316 stainless steel. Interior floor, and wall surfaces shall be fiberglass.

B. The enclosure shall be molded fiberglass construction, factory pre-assembled to make a bonded unit with no external seams or joint covers.

C. There shall be a three-inch (minimum) wide mounting flange around the entire lower perimeter of the enclosure.

D. Dimensions shown on drawings are minimum required dimensions. Contractor shall modify the concrete foundation as required at no additional cost to the Owner.

2.02 DOORS AND FRAMES

A. The walls and roof of the enclosure shall be integral and shall be of sandwich construction consisting of 1/8-inch thick fiberglass skins and one inch thick rigid polyisocyanurate foam core.

B. The enclosure shall be equipped with two sets of double doors for insertion and removal of the chemical drums or totes and shall be configured as shown on the plans.

C. The doors shall be of fiberglass sandwich construction 1-3/4 inches thick.

2.03 ELECTRICAL

A. General

1. The following general requirements shall apply for all the equipment provided and installed within the prefabricated enclosure:

   a. All equipment shall be suitable for corrosive chemical environment and shall comply with the requirements of Division 26.

   b. Provide NEMA 4X Fiberglass enclosure for all provided electrical equipment installed inside of the chemical storage and feed enclosure.
c. All provided electrical equipment including disconnect switch, transformer, panelboard, breakers and lighting equipment shall be appropriately sized according to the NEC standard.

d. Provide Sch 40 PVC electrical conduits per Division 26.

e. All wiring, lighting, wiring devices and electrical equipment shall be suitable for exposure to chlorine gas.

f. The total electrical loads of the chemical storage and feed enclosure shall not exceed 15 kVA.

g. All panels, transformers, lighting and ventilation equipment shall be prewired by the enclosure manufacturer.

B. Equipment

1. The following equipment shall be provided by the prefabricated chemical storage enclosure manufacturer and wired to provide a fully operational system:

   a. One 120/240VAC panelboard, 125A bus with a main breaker sized to carry the load associated with the building and the metering pumps and complying with the requirements of Division 26. Panelboard shall have circuits to cover all the electrical loads provided with the building (Indoor and outdoor lighting, receptacles, heating, ventilation, etc.), the chemical feed pumps and (2) heat trace circuits for the outdoor water lines. Breakers for the heat trace circuits shall be GFCI.

   b. Provide (2) 120 VAC receptacles to power the chemical feed pumps that will be housed in the enclosure. Provide (2) receptacles for general use. Receptacles shall comply with the requirements of Division 26.

2.04 HEATING, VENTILATION AND AIR CONDITIONING

A. Provide a pre-wired fiberglass supply fan capable of providing a minimum of 20 air changes per hour.

B. The enclosure shall be pre-wired with a thermostatically-controlled heater. All wiring and electrical components shall be suitable for use in an enclosure housing sodium hypochlorite, with occasional low concentrations of chlorine gas in the interior environment.

2.05 LIGHTING

A. The enclosure shall be pre-wired with lights, including exterior switches. Interior light shall be vapor-resistant. Lighting shall provide a minimum of 20 fc inside the enclosure. Provide 2 exterior lights that are photocell controlled, one at each door.

2.06 PAINTING

A. Interior and exterior surfaces shall be finished in white polyester gel coat with UV inhibitors.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. The enclosure shall be stored on dunnage placed at the proper locations to prevent cracking, distortion, or any other physical damage.
B. The enclosure shall be provided with lifting fixtures for lifting and setting the enclosure without incurring damage to the walls or roof.

C. The Enclosure Manufacturer shall provide all cables and lifting hardware for use in off-loading and setting the enclosure.

D. Provide anchorage necessary to fasten the enclosure to the concrete pavement and to resist appropriate wind loads.

END OF SECTION
SECTION 2600 00

ELECTRICAL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work includes, but is not limited to, the following principal systems and equipment:
   1. 120/208-Volt Systems.
   2. Low Voltage Electrical Power Conductors and Cables.
   5. Electrical Heat Tracing.
   6. Grounding and Bonding.
   7. Surge Protective Devices.
   8. Panelboards.
   9. Miscellaneous Controls, Panels and Equipment.
   10. Lighting.

1.02 RELATED WORK

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

1.03 SUBMITTALS

A. Data Required:
   1. Submit shop drawings, product data and all other required information as specified in Division 1. Submittals are required on all products and items to be installed on this project.
   2. Submittal data must show manufacturer's name, published ratings or capacity data, detailed equipment drawing for fabricated items, panel diagrams, wiring diagrams, installation instructions and other pertinent data.
   3. Where literature is submitted covering a group or series of similar items, the applicable items must be clearly indicated. Mark through items not being provided and clearly identify all options being provided.
   4. Do not combine submittals for multiple Specifications Sections.

B. Submit a letter showing all the exception to the specification. If no exceptions are taken the letter shall indicate no exception. Submittal will be rejected without preliminary review if the letter is not submitted.

C. Submittal Items: Submittals are required for all equipment and materials to be used on this project. Submittals shall be complete with all pertinent information and installation details. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's Representative, and such procedures will not be cause for delay.
D. Terminal Connection Diagrams:
   1. Submit terminal connection diagrams for approval prior to any wire installation.
   2. Submit finalized terminal connection diagrams at the end of the Contract.
   3. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

1.04 REFERENCE STANDARDS

A. Perform work, furnish and install materials and equipment in full accordance with the latest issue of the applicable rules, regulations, requirements, and specifications of the following:
   1. Local laws and ordinances.
   4. State Fire Marshal.
   5. Underwriters' Laboratories (UL).
   8. National Electrical Manufacturer's Association (NEMA).
  10. Institute of Electrical and Electronics Engineers (IEEE).
  11. Insulated Cable Engineers Association (ICEA).
  12. Occupational Safety and Health Act (OSHA).
  16. American Concrete Institute (ACI).
  18. Insulated Power Cable Engineers Association (IPCEA).
  19. Association Edison Illuminating Company (AEIC).

B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory.

C. Product Quality: All electrical items shall be new and unused. Items such as cables, transformers, motors, control centers, etc., shall be newly manufactured for this project. Proof of purchase documents shall be provided upon request. Utilize products of a single manufacturer for each item.

1.05 QUALITY ASSURANCE

A. Regulations and permits:
   1. Regulations: Work, materials and equipment must comply with the latest rules and regulations of the following:


c. Standard for Electrical Safety in the Workplace (NFPA70E).


e. Occupational Safety and Health Act (OSHA).

f. State and federal codes, ordinances and regulations.

g. Local Electrical Code.

2. Permits: Obtain certificates of inspection and other permits required as a part of the work.

B. Contractor qualifications:

1. An acceptable Contractor for the work under this division must have personnel with experience, training, and skill to provide a practical working system. The Contractor shall have previous water and wastewater experience with at least 5 years in business.

   a. The Contractor shall be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project.

   b. The systems must have served satisfactorily for not less than 3 years.

   c. The superintendent must have had experience in installing not less than three systems.

   d. The Contractor shall submit qualifications of his firm and resumes of his personnel who will work on this project.

C. General requirements for workmanship, equipment and materials:

1. All electrical work shall be performed by workmen skilled in the electrical trade and licensed for the work by the local authority.

2. A licensed Master Electrician will be required for the issuance of a building permit for constructing, installing, altering, maintaining, repairing, or replacing any electrical wiring, apparatus, or equipment on any voltage level. A licensed Master Electrician or a licensed Journeyman Electrician holding a current license in the state of Texas is required to be on the job site during the performance of any electrical work. Master Electrician shall spend minimum of 4 hrs per week at the job site reviewing work completed.

3. All cable splicing and termination methods and materials shall be of the type recommended by the splicing materials manufacturer for the cable to be spliced, and shall be approved by the Engineer prior to installation.

4. All materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer, the best practices of the trade, and in conformance with the Contract Documents. The Contractor shall promptly notify the Owner in writing of any conflict between any requirements of the Contract Documents and manufacturer's directions, and shall obtain written instructions from the Owner before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or such written instructions from the Owner, he shall bear all costs arising in correcting deficiencies.

5. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the manufacturer's name, trademark and ASME, UL, and/or other labels in every case where a standard has been established for the particular item. Equipment shall be the latest approved design of a standard product of a manufacturer regularly engaged in the production of the required type of equipment, and shall be supported by a service organization that is, in the opinion of the Owner, reasonably convenient to the site.

6. The Electrical design is based on preliminary equipment selections. If the contractor provides equipment that is larger than the selections, the contractor is responsible for
upsizing all cables, starts, overloads, transformers, etc. to meet the National Electrical Code and provide an overall voltage drop of less than 5%. It is the responsibility of the Contractor to insure that items furnished fit the space available with adequate room for proper operation and maintenance. He shall make measurements to verify space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that, in the final inspection, will suit the true intent and meaning of the Plans, Specifications and Contract Documents.

7. The Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to complete the work, ready for use and operation by the Engineer/Owner.

8. When the Engineer/Owner has reviewed equipment submittals and given instructions to proceed with the installation of items of equipment that require arrangements or connections different from those shown on the drawings, it shall be the responsibility of the Contractor to install the equipment to operate properly and in accordance with the intent of the Plans and Specifications, and he shall provide any additional equipment and materials that may be required. The Contractor shall be responsible for the proper location of roughing-in and connections by other trades. All changes shall be made at no increase in the Contract Amount or additional costs to other trades.

9. The Contractor shall support the installation of all equipment, plumb, rigid and true to line. The Contractor shall determine how equipment, fixtures, conduit, etc., are to be installed, and shall provide foundations, bolts, inserts, stands, hangers, brackets and accessories for proper support whether or not shown on the drawings.

D. System responsibility

1. The Contractor shall be responsible for:
   a. Complete systems in accordance with the intent of these Contract Documents.
   b. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 26, Electrical.
   c. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
   d. Coordinate the work with the instrumentation Contractor.
      (i) The Instrument Contractor shall furnish and install the primary and secondary instruments, i.e. level element and level indicating transmitter, flow transmitter, etc.
      (ii) The conduit and wiring to and from the instruments shall be furnished and installed by the Electrical Contractor. Termination in the instrument shall be by the Instrument Contractor.
      (iii) All terminations in the control panel shall be by the Instrument Contractor.
      (iv) The Electrical Contractor shall provide termination drawings for the instrumentation Contractor.
      (v) The equipment pad for the control panels, consoles and instrument panels shall be furnished by the Electrical Contractor.
      (vi) The Electrical Contractor shall coordinate the testing of the electrical system being furnished. He shall be responsible for the equipment he is supplying.
      (vii) The Electrical Contractor shall be present at time of the instrument system testing and start-up. He shall be responsible to coordinate the testing of the facility with the Instrument Contractor.
(viii) The Electrical Contractor shall coordinate the interface requirement between each starter and control panel furnished under this Contract with the Instrument Contractor.

(ix) Written proof shall be furnished and submitted to the Engineer prior to installation to verify that a clear understanding has been reached between the Electrical Contractor and the Instrument Contractor for each control loop requirements, (e.g. type of contacts (momentary, maintained), interface relay requirement number of wires, terminal marking, control schematic information, and wiring diagrams).

2. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.

3. Submit to the Engineer in writing details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. Submit such request as soon as practicable, and within ten (10) days after award of the Contract. Make no such departures without written approval of the Engineer.

4. Dimensions on electrical drawings shall be verified with structural, architectural, and mechanical drawings.

5. Where the Contractor is submitting a packaged system, Contractor shall meet the requirements of electrical specifications. This includes field cables, conduits, junction boxes, circuit breakers, combination starters, pushbuttons, pilot lights, and motors. Deviations shall not be accepted, unless approved in writing in advance. Control centers and special control cabinets wired to terminal blocks shall include the manufacturer's standard quality, unless specifically mentioned to the contrary on the drawings or in the specifications.

6. Maintain continuity of electric service to functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such times and places can be prearranged with the Owner's designated Representative. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer. Include costs for temporary wiring and overtime work required in the Contract price. Remove temporary wiring at the completion of the work. The Contractor shall be responsible to provide and pay for temporary power to any facility during construction to facilitate the new construction. If a generator is needed the contractor shall be responsible for all the cost associated with, including fuel.

7. Unless shown in detail, the drawings are diagrammatic and do not necessarily give exact details as to elevations and routing of raceways, nor do they show all offsets and fittings; nevertheless, install the raceway system to conform to the structural and mechanical conditions of the construction.

8. Cabling inside equipment shall be carefully routed, trained, and laced. Placing cables so that they obstruct equipment devices is not acceptable.

1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS

A. Intent of contract documents:

1. The intent of the contract drawings or Plans is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.
2. Electrical drawings are generally diagrammatic and show approximate location and extent of work.
3. Install the work complete, including minor details necessary to perform the function indicated.
4. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the Engineer.
5. It is also the intent of these Contract Documents for the electrical and process system Contractor to coordinate with each other in order to provide a complete and workable system with all wiring, conduit and accessories required which may not be shown on the Plans.
6. The Plans and Specifications are intended to comply with listed codes, ordinances, regulations and standards.

B. Discrepancies:
1. Review pertinent drawings and adjust the work to conditions shown.
2. Where discrepancies occur between Plans, Specifications, and actual field conditions, immediately notify the Engineer in writing and ask for an interpretation.
3. Dimensions on electrical drawings shall be verified with structural, architectural and mechanical drawings.
4. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation.
5. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirement, provide those specified or shown.

C. Outlet and Equipment Locations:
1. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on architectural, structural and mechanical drawings.
2. Review with the Engineer any proposed changes in outlet or equipment location.
3. Relocation of outlets before installation, up to 3 feet from the position indicated, may be directed by Owner without additional cost.
4. Remove and relocate outlets placed in an unsuitable location, when so requested by the Engineer.

1.07 DELIVERY, HANDLING AND STORAGE
A. Refer to individual sections for delivery, handling and storage instructions associated with each piece of equipment.

1.08 MAINTENANCE AND SPARE PARTS
A. Refer to individual sections for maintenance and spare parts associated with each piece of equipment.

1.09 WARRANTY/EXTENDED WARRANTY
A. Refer to individual sections for maintenance and spare parts associated with each piece of equipment.

PART 2 PRODUCTS
2.01 MATERIALS

A. Condition: Materials and equipment provided under these Specifications must be new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer’s latest standard design for the type of equipment specified.

B. NEC and UL: Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products, and issued labels, products used must be listed and labeled by UL.

C. NEMA and IEC: Only NEMA rated equipment is acceptable. IEC or dual rated NEMA/IEC equipment are not acceptable.

D. Space Limitations: Equipment selected must conform to the building’s features and must be coordinated with them. Do not provide equipment that will not suit arrangement and space limitations.

E. Factory Finish: Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required.

F. Field Installation: All field installed equipment, conduit, etc., shall require Type 316 stainless steel nuts, bolts, washers, metal framing and supports, and other items as indicated on the Plans.

G. Seismic Design: All electrical equipment to be designed in accordance with the latest IBC & ASCE 7 code for Seismic Design.

2.02 FABRICATION (NOT USED)

2.03 CONTROLS (NOT USED)

2.04 FACTORY TESTS (NOT USED)

PART 3 EXECUTION

2.05 DEMOLITION/PREPARATION

A. Protection Of Equipment
   1. Moisture:
      a. During construction, provide heaters to protect switchgear, transformers, motors, control equipment, and other items from moisture absorption and corrosion.
      b. Apply protection immediately on receiving the products and provide continuous protection.
      c. Store all equipment indoors in dry, well ventilated and heated space.
   2. Clean: Keep products clean by elevating above ground or floor and by using suitable coverings.
   3. Damage:
      a. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
      b. Provide rodent damage protection to switchgear, transformer, etc and any other electrical equipment during any storage and/or construction times.
4. Finish: Protect factory finish from damage during construction operations and until final acceptance of the project.
   a. Protect Equipment per the manufacturer’s requirements.

2.06 INSTALLATION

A. Cooperation with Other Trades:
   1. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.
   2. Coordinated equipment layout in sufficient time to be coordinated with work of others, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

B. Workmanship: Work must be performed by workmen skilled in their trade. The installation must be complete whether the work is concealed or exposed.

C. Setting of Equipment:
   1. Equipment must be leveled and set plumb.
   2. Stainless Steel 316 enclosures mounted against a wall must be separated from the wall no less than 1/2-inch by means of corrosion resistant spacers or by 3 inches of air for freestanding units.
   3. Stainless Steel 316 bolts, nuts, and washers to anchor the equipment.

D. Sealing of Equipment:
   1. Permanently seal outdoor equipment at the base using concrete grout.
   2. Seal or screen openings into equipment to prevent entrance of animals, birds and insects.
   3. Use stainless steel mesh with openings not larger than 1/16-inch squares for screened openings.
   4. Seal small cracks and openings from the inside with silicone sealing compound.

E. Concealed Work: Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:
   1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
   2. Where exposure is necessary to the proper function.
   3. Where size of materials and equipment precludes concealment.

F. Equipment to be installed in Hazardous areas shall be in accordance with NEC article 500 and NFPA 820.

G. Installation and supply of electrical equipment shall be conformed to NEC 500, for classified area.

H. Project record documents
   1. Preparation:
      a. At the job site, maintain a set of white prints of the contract drawings.
      b. At the job site, maintain a set of equipment terminal connection diagrams, revisions to be included in the as built drawings.
c. On the prints, record field changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings.
d. Mark the drawings with a colored pencil. Record installed feeder conduits, dimensioning the exact location and elevation of the conduit.

2. Delivery: Deliver record drawings to the Engineer in the number and manner specified in Division 1 - General Requirements.

I. Cutting and Pasting
1. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of the Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Do not cut beams for any reason. Following such work, restore surfaces neatly to original condition.

J. Load Balance
1. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, etc.

K. Motor rotation
1. Before and after final service connections are made, check and correct as necessary the rotation of motors.
2. Coordinate rotation checks with the Engineer and the Contractor responsible for the driven equipment. Submit a written report to the Engineer for each motor verifying that rotation has been checked and corrected.

2.07 INSPECTION
A. Refer to individual sections for inspections to be performed for each piece of equipment.

2.08 FIELD TESTING
A. Test Conditions:
1. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation.
2. Perform specified tests in the presence of the Engineer, as specified in Division 1 - General Requirements and 26 - Electrical.
3. Furnish all instruments, wiring, equipment, and personnel required for conducting tests.
4. Demonstrate that the equipment operates in accordance with requirements of the plans and specifications.
5. No process equipment is to be operated until any associated HVAC equipment and auxiliary equipment is operational.

B. Test Dates: Schedule final acceptance tests sufficiently in advance of the Contract completion date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the Contract.

C. Retests: Conduct retests as directed by the Engineer of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant
delay as a result of such necessary retests does not relieve the Contractor of his responsibility under this contract. Provide notice to Engineer and Owner of testing 30-days prior to testing.

2.09 FIELD PAINTING

A. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides finish equal to or better than the factory finish, and that meets the requirements of the Specifications and is acceptable to the Engineer.

2.10 CLEANING

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps of equipment shall be left on the premises.

B. All temporary wiring, wiring devices and associated equipment shall be removed upon completion of the project.

END OF SECTION
SECTION 26 05 19
LOW VOLTAGE ELECTRICAL
POWER CONDUCTORS AND CABLES

PART I  GENERAL

1.01  SCOPE OF WORK

A. Furnish and install, complete and ready for operation, electrical conductor systems as shown on
the drawings and as specified herein.

1.02  RELATED WORK

A. Other sections that may relate to the work in this section include, but are not limited to, the
following:
1. Uniform General Conditions
2. Division 1 General Requirements and Special Conditions
3. 26 00 00 – Electrical.

1.03  SUBMITTALS

A. Literature and drawings describing the equipment in sufficient detail, including parts list and
materials of construction, to indicate full conformance with the Specifications.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment
option not provided.

C. Submit a letter certifying full and complete compliance with the specifications, drawings and
other project requirements. The letter shall list any exceptions or deviations from the specified
requirements, if any and reasons for same. Exceptions or deviations shall also be clearly
marked in a separate color in submittals.

1.04  REFERENCE STANDARDS

A. The following standards shall apply as if written here in their entirety:
1. ICEA - Insulated Cable Engineers Association.
2. AEIC - Association of Edison Illuminating Companies.
4. UL 510 - Standard for Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
5. UL 44 - Thermoset-Insulated Wires and Cables.
6. ANSI/NEMA WC 70/ICEA S-95-658 – Power Cables Rated 2000 Volts or Less for the
   Distribution of Electric Energy.
7. IEEE 1202 - Flame Testing of Cables for Use in Cable Tray.
8. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors,
   Hard, Medium-Hard, or Soft.
1.05 QUALITY ASSURANCE
   A. The general construction of the cable and the insulation material used shall be similar to that used for cable of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities. Upon request, the manufacturer shall submit a copy of his Quality Assurance Manual detailing the quality control and quality assurance measures in place at his facility.
   B. The manufacturer shall have available for audit detailed descriptions of the method by which his various manufacturing processes and production test are recorded, thus enabling the "traceability" of the completed cable. All steps in the manufacturing process, from receipt of raw material to the final tests, are to be included. Where multiple records are used, the method for cross-referencing shall be noted.

1.06 SYSTEM DESCRIPTION/DESIGN REQUIREMENTS (NOT USED)

1.07 DELIVERY, HANDLING AND STORAGE
   A. Check for reels not completely restrained, reels with interlocking flanges or broken flanges, damaged reel covering or any other indication of damage. Do not drop reels from any height.
   B. Unload reels using a sling and spreader bar. Roll reels in the direction of the arrows shown on the reel and on surfaces free of obstructions that could damage the cable.
   C. Store cable on a solid, well drained location. Unjacketed armored cable shall be stored indoors. Cover cable reels with plastic sheeting or tarpaulin. Do not lay reels flat.
   D. Seal cable ends with heat shrinkable end caps. Do not remove end caps until cables are ready to be terminated.

1.08 MAINTENANCE / SPARE PARTS (NOT USED)

1.09 WARRANTY / EXTENDED WARRANTY
   A. The manufacturer shall warrant the cable against failures for a period of 20 years from date of installation and shall remove and replace failed cables at his own expense during this warranty period.

PART 2 PRODUCTS

2.01 MATERIALS
   A. General
      1. Use the manufacturer's name, model or catalog number, if for the purpose of establishing the standard of quality and general configuration desired only.
      2. Splices are not acceptable on this project, except at light fixtures and receptacles.
   B. Conductors - 600 Volts
      1. Single Conductors 600 Volts and Below:
         a. Unless otherwise indicated, all conductors shall be copper and shall be stranded. Solid conductors shall not be used. All conductors with the exception of grounding conductors shall be standard copper.
b. Utilize only conductors meeting applicable requirements of UL 44, UL 1685, IECA S-95-658 (NEMA WC70).

c. Provide conductors with type XHHW-2 insulation. Wire shall be TC rated where used in cable trays.

d. Unless noted otherwise, conductor sizes indicated are based on copper conductors. Do not provide conductors smaller than those indicated.

e. Where flexible cords and cables are specified, provide Type STJO, 600 volt, with the number and size of copper conductors indicated.

2. Single Pair (600 Volt No. 16 AWG Twisted, shielded Pair Instrumentation Cable, Type TC):

a. General: Single pair instrumentation cable designed for noise rejection for process control, computer, and data log applications. Suitable for installation in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, 75° C wet locations.

b. Individual Conductors: Soft annealed copper, Class B, 7-strand concentric per ASTM B 8, 22 AWG, 7-strand copper drain wire.

c. Insulation and Jacket: Each conductor XHHW-2. Pair conductors pigmented black and white. Jacket flame-retardant and sunlight and oil resistant PVC with 45 mils nominal thickness. Shield aluminum/Mylar overlapped to provide 100 percent coverage

d. Dimension: 0.30 inch nominal OD

e. Manufacturers: Alpha Wire Corporation, Belden, General Cable, the Okonite Company.

3. Single Triad (600 Volt No. 16 Twisted, Shielded Triad Instrumentation Cable, Type TC):

a. General: Single triad instrumentation cable designed for noise rejection for process control, computer, or data log applications. Suitable for installation in cable tray, conduit, or other approved raceways. Minimum cable temperature rating shall be 90°C dry locations, 75°C wet locations.

b. Conductors: Soft annealed copper, Class B, 7-strand concentric per ASTM B 8, 22 AWG, 7-strand copper drain wire.

c. Insulation and Jacket: Each conductor, XHHW-2 insulation. Triad conductors pigmented black, red, and white. Jacket flame-retardant and sunlight and oil retardant PVC with 45 mils nominal thickness. Shield aluminum/Mylar, overlapped to provide 100 percent coverage.

d. Dimensions: 0.32-inch nominal OD.

e. Manufacturers: Alpha Wire Corporation, Belden, General Cable, the Okonite Company.

4. Equipment Grounding Conductors:

a. Refer to specification section 26 05 26: Grounding and Bonding for Electrical Systems for grounding conductor information.

b. Tinned conductors on power and controls.

2.02 FABRICATION (NOT USED)

2.03 CONTROLS (NOT USED)
2.04 FACTORY TESTS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION / PREPARATION (NOT USED)

3.02 INSTALLATION

A. General

1. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Pulling compound shall be used. Use only UL listed compound compatible with the cable outer jacket and with the raceway involved.

2. CONTRACTOR is to provide and install all low voltage (120V, 208V, 480V, etc.) distribution equipment and hardware associated with this project as shown on the plan drawings.

3. Tighten screws and terminal bolts using torque type wrenches, and/or drivcs, to tighten to the inch-pound requirements of the NEC and UL.

4. Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, bundle throughout their exposed length conductors entering from each conduit with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 12 inches on centers.

5. Provide conductor sizes as indicated on the drawings with 600V rated insulation.

6. Use silicone filled pressure connectors. Place no more than one conductor in any single-barrel pressure connection.

7. Motors connector shall be crimp connectors or kernys varnish carbonic C130.

8. Soldered mechanical joints insulated with tape will not be acceptable.

9. Vinyl plastic insulating tape for wire and cable splices and terminations shall be flame retardant, 8.5-mil thick minimum, rated for 105°C minimum meeting the requirements of UL 510. Acceptable product 3M-Scotch 88.

10. Provide terminals and connectors acceptable for the type of material used.

11. Arrange wiring in cabinets, panels, and motor control centers neatly cut to proper length. Remove surplus wire, and bundle and secure in an acceptable manner. Identify circuits entering motor control centers or other control cabinets in accordance with the conductor identification system specified herein.

12. For terminals designed to accept only bare wire compression terminations, use only stranded wire, and terminate only one wire per terminal. Tighten terminal screws with torque screwdriver to recommended torque values.

13. Attach compression lugs with a tool specifically designed for that purpose which provides a complete, controlled, crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.

14. Cap spare conductors and conductors not terminated with UL listed end caps.

15. Where conductors pass through holes or over edges in sheet metal, remove all burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
16. For conductors that will be connected by others, provide at least 6 feet spare conductor in freestanding panels, and at least 2 feet spare in other assemblies. Provide more spare conductors in any particular assembly where it is obvious that more conductor length will be needed to reach the termination point.

B. Conductor Color Coding

1. For power conductors, provide all single conductors power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 may be provided with color-coding by wrapping the conductor at each end and at all accessible locations with vinyl tape. Where this method of color-coding is used, wrap at least six full overlapping turns of tape around the conductor covering an area 1-1/2 to 2 inches wide at a visible location.

2. Phase A, B, and C implies the direction of positive phase rotation.

3. Use owner’s current color scheme. If owner does not have a consistent color scheme use the following:

<table>
<thead>
<tr>
<th>System</th>
<th>Conductor</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Systems</td>
<td>Equipment Grounding</td>
<td>Green</td>
</tr>
<tr>
<td>240/120 Volts</td>
<td>Grounded Neutral</td>
<td>White</td>
</tr>
<tr>
<td>1-Phase, 3-Wire</td>
<td>One Hot Leg</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>Other Hot Leg</td>
<td>Red</td>
</tr>
<tr>
<td>208Y/120 Volts</td>
<td>Grounded Neutral</td>
<td>White</td>
</tr>
<tr>
<td>3-Phase, 4-Wire</td>
<td>Phase A</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>Phase B</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>Phase C</td>
<td>Blue</td>
</tr>
<tr>
<td>480Y/277 Volts</td>
<td>Grounded Neutral</td>
<td>Gray</td>
</tr>
<tr>
<td>3-Phase, 4-Wire</td>
<td>Phase A</td>
<td>Brown</td>
</tr>
<tr>
<td></td>
<td>Phase B</td>
<td>Orange</td>
</tr>
<tr>
<td></td>
<td>Phase C</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

C. Installation

1. Do not splice without permission of the OWNER’S REPRESENTATIVE. Locate splices, when permitted, only in readily accessible cabinets or junction boxes using terminal strips.

2. Cable Placement:
   a. Immediately prior to the placement of each cable or cable group, inspect the raceway to determine that installation is complete and that the interior is clean and free of all materials detrimental to the cable or its placement. Group all cable assigned to a particular conduit and pulled simultaneously, using cable grips and acceptable lubricants.
   b. Provide adequately sized raceways to accommodate the number and size of cable as specified, and in compliance with Article 300 of the National Electric Code. If at any time during the progress of the work raceways appear inadequate to accommodate the assigned cable, notify the Owner’s Representative/Owner at once and discontinue further work on the questionable raceway until advised by the Owner as to how to proceed.
c. Carefully check all cable as to size and length before pulling into conduits. Remove and replace cable pulled into the wrong conduit or cut too short at no additional cost to the Owner's Representative/Owner. Do not pull cable removed from one conduit or duct into another conduit or duct without permission of the Owner's Representative/Owner.

d. Fishing and pulling shall be performed with flexible round non-metallic tape, carbon dioxide, or forced air propelled polyethylene cord, nylon rope, or manifold rope. No metallic cable or material that may damage or scratch the inside surface shall be pulled into any conduits.

3. Use woven wire cable grips to pull all low voltage single conductor cable, No. 2/0 and larger and all low voltage multi-conductor cable. Use pulling loops to pull single conductor cable smaller than No. 2/0. When a cable grip is used for pulling, the arc of the cable covered by the grip plus 6-inches shall be cut off and discarded.

4. Insert a reliable non-freezing type of swivel or swivel connection between the pulling ropes and the cable eye, or grip to prevent twisting under strain.

5. Do not exceed the maximum pulling tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable, and the indicator shall be constantly watched. If any excessive strain develops, stop the pulling operation at once and determine and correct the difficulty.

D. Conductor Arc and Fireproofing Tapes

1. Use arc and fireproofing tapes on 600 volt single conductors and cables, except those rated Type TC, throughout their entire exposed length at splices in manholes, handholes, vaults, cable trays, and other indicated locations.

2. Wrap together as a single cable conductors entering from each conduit.

3. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.

4. Arc and Fireproofing tape shall be 3M Scotch #77 or equal.

3.03 INSPECTION (NOT USED)

3.04 FIELD TESTING

A. Pulling tensions shall be recorded for all cable runs longer than 200 feet.

3.05 FIELD PAINTING (NOT USED)

3.06 CLEANING (NOT USED)

END OF SECTION
SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK
A. Furnish and install grounding and bonding equipment for the electrical system. It is the intention of this specification that all electrical equipment be grounded. Furnish labor, materials, equipment and incidentals necessary to install a complete grounding system in strict accordance with Article 250 of the National Electrical Code (NEC) as shown on the drawings or as specified herein. Electrical work shall be in accordance with Division 26 - Electrical.

1.02 RELATED WORK
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Other sections that may relate to the work in this section include, but are not limited to, the following:
   1. UGCs and General Requirements; Special Conditions.
   2. 26 00 00 - Electrical.

1.03 SUBMITTALS
A. Submittal shall be in accordance with Division 1 and shall include:
   1. Grounding materials, equipment and processes.
   2. Product Data: For each type of product supplied.
   3. Field quality-control test reports.
B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.
C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.
D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04 REFERENCE STANDARDS
A. The following standards shall apply as if written here in their entirety:
   2. ANSI/UL 467 - Grounding and Bonding Equipment.
1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS

A. Measure the ground grid resistance with the earth test medger and install additional ground rods and conductors as required until the resistance to the ground conforms to National Electrical Code requirements. Ground resistance measurement shall not exceed 5 ohms.

1.07 DELIVERY, HANDLING AND STORAGE (NOT USED)

1.08 MAINTENANCE / SPART PARTS (NOT USED)

1.09 WARRANTY/EXTENDED WARRANTY (NOT USED)

PART 2 PRODUCTS

2.01 MATERIALS

A. Ground Rods
   1. Material: GROUND RODS: Copper-clad having a diameter of 3/4" and a minimum length of 10'.
   2. Listing: UL 467.

B. Ground Cables
   1. Stranded, bare copper of 98% conductivity and as specified in Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.

C. Conduit Ground Fittings
   1. Fittings for bonding ground cable to the conduit shall be FCI Burndy Corp., type NE or Thomas & Betts No. 3951 series.

D. Ground Rod Boxes
   1. Precast Box with cast iron lid. Lid shall read "ground rod" on lid. Brooks Precast Model. "3-RT" or approved equal. Ground rod boxes shall have an AASHTO H-20 rating.

E. Ground Plate Electrodes
   1. 20 gauge copper with terminated two (2) foot welded pigtail connection.

F. CONNECTIONS
   1. Type:
      a. Unless otherwise noted, provide exothermic weld typed for all non-accessible and below-grade connections.
      b. For above grade connections provide bonds and clamps of a nonferrous material which will not cause electrolytic action between the conductor and the connector.
   2. Listing: UL 467.
   3. Acceptable Manufacturers:
a. Below grade:
   (i) Cadweld.
   (ii) Thermoweld.

b. Above grade:
   (i) Burndy.
   (ii) Ilsco.
   (iii) Erico.
   (iv) OZ/Gedney.
   (v) T & B.

G. Certification
   1. Contractor shall receive from the manufacturer proper training prior to execute the exothermic weld connection.

H. Wiring
   1. Provide copper insulated conductors for bonding jumpers. All insulated grounding conductors shall be copper, stranded.
      a. Provide 600-volt insulated conductors having a green-colored XHHW insulation for equipment grounding conductors, or green heat shrink over XHHW insulation in accordance with NFPA 70E.
      b. Ground conductors shall be protected in conduit where subject to physical damage.
      c. All exposed ground conductors shall be installed in conduits. Ground conductor attached to cable trays shall not be considered exposed.
      d. Ground wire shall be un-insulated copper where ground wire is directly buried in earth or concrete.

I. Ground Bus
   1. Round-edge tin plated copper bar with 98 percent International Annealed Copper Standard (IACS) conductivity.
   2. Size the bus for not less than 25 percent of the cross-sectional area of the related feeder.
   3. A minimum ground bus size of 3-inch by 2 inches is required.

J. Grounding for Instrumentation System
   1. Ground Loop for instrumentation system shall be grounded at only one point to the building ground system.

K. Ground Loop
   1. All ground loop conductor shall be bare copper minimum wire size shall be #4/0 unless otherwise noted.

2.02 FABRICATION (NOT USED)
2.03 CONTROLS (NOT USED)
2.04 FACTORY TESTS (NOT USED)
PART 3 EXECUTION

3.01 DEMOLITION / PREPARATION (NOT USED)

3.02 INSTALLATION

A. System Ground
   1. System Neutral:
      a. Where a system neutral is used, ground the system neutral conductor as required by NEC Article 250.
      b. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.
   2. Separately Derived Systems: Ground neutrals of separately derived systems such as generators, transformers, etc., in accordance with NEC 250-30.
   3. Size: Size the system grounding conductors to comply with NEC Table 250-66, unless shown larger.

B. Equipment Ground
   1. Raceway Systems and Equipment Enclosures:
      a. Ground cabinets, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, transformer enclosures, handrail, stair, steel pipe and other equipment and metallic enclosures.
      b. Ground equipment and enclosures to the continuous-grounded, metallic raceway system in addition to any other specific grounding shown.
      c. Provide bonding jumpers and ground wire throughout to ensure electrical continuity of the grounding system.
      d. Provide grounding-type insulated bushings for metal conduits terminating in equipment enclosures containing a ground bus and connect the bushing to the ground bus.
      e. Provide green insulated equipment grounding conductor for each feeder, power branch circuit, receptacle branch circuit and lighting branch circuit.
      f. Raceways shall not be used for equipment ground. Provide individual equipment ground wires for all equipment even if not shown on plans.
      g. Provide bonding jumper and bonding bushing on each metallic conduit entering or leaving the enclosure of the service equipment.
      h. Where grounding conductors are shown, bond the wires to metallic enclosures at each end and to intermediate metallic enclosures. Connect grounding conductors to grounding bushings on raceway. Where any equipment contains a ground bus, extend and connect grounding conductors to that bus. Run ground conductor inside conduits enclosing the power conductors.
      i. Make connections of any grounding conductors to motors ½ HP and above, or circuits 20 amps or above, by solderless terminal and a 5/16-inch minimum bolt tapped to the motor frame or equipment housing. Grounding clips mounted directly on the box, or with 3/8-inch machine screws. Completely remove all paint, dirt, or other surface coverings at grounding conductor at connection points so that good metal-to-metal contact is made.
      j. Ground metal sheathing and any exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond any metal equipment platforms which support electrical equipment to that equipment. Provide
good electrical contact between metal frames and railings supporting pushbutton stations, receptacles, instrument cabinets, etc., and raceways carrying circuits to these devices.

k. Bond neutrals of transformers to the system ground network, and to any additional indicated grounding electrodes.

2. Size:
   a. When grounding and bonding conductors are not sized on drawings, size the grounding conductors in accordance with NEC Table 250-122.
   b. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250-122.

3. Install sufficient ground rods in addition to those shown, or code required grounding so that resistance to ground as tested by standard methods does not exceed 5 ohms. Where more than one rod is required, install rods at least 10 feet apart.

C. Ground Connections
   1. Unless shown otherwise, make connections of grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection point below finished grade.
   2. Make connections of sections of outdoor ground mats (counterpoise) for substations or other equipment underground. Make connections of other grounding conductors generally accessible.
   3. When making thermite welds, wire blush or file the point of contact to a bare metal surface. Use thermite welding cartridges and molds in accordance with the manufacturer’s recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly clean the joint. For compression connectors, use homogeneous copper, anti-corrosion, surface treatment compound at connectors in accordance with connector manufacturer’s recommendations. Use connectors of proper size for conductors and ground rods specified. Use connector manufacturer’s compression tool. Notify Owner’s Representative prior to backfilling any ground connections.

3.03 INSPECTION (NOT USED)
3.04 FIELD TESTING (NOT USED)
3.05 FIELD PAINTING (NOT USED)
3.06 CLEANING (NOT USED)

END OF SECTION
SECTION 26 05 29
HANGERS AND SUPPORTS
FOR ELECTRICAL SYSTEMS

PART 1  GENERAL

1.01  SCOPE OF WORK
   A.  Hangers and supports for electrical equipment and systems.
   B.  Construction requirements for concrete bases.

1.02  RELATED WORK
   A.  Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
   B.  Coordinate installation of roof curbs, equipment supports, and roof penetrations.
   C.  Other sections that may relate to the work in this section include, but are not limited to, the following:
      1.  UGCs and General Requirements; Special Conditions.
      2.  26 00 00 - Electrical.

1.03  SUBMITTALS
   A.  Product Data:
      1.  Outdoor, dry well, wet well, and corrosive installation: 316 stainless steel slotted support systems, with stainless steel support and mounting hardware.
      2.  Indoor air conditioned spaces: Galvanized steel slotted support systems with galvanized steel support and mounting hardware.
   B.  Record data: Show fabrication and installation details for the following:
      1.  Trapeze hangers: Include Product Data for components.
      2.  Equipment supports and connections detail.
   C.  Welding certificates.
   D.  Field Test Report.
   E.  Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.
   F.  Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04  REFERENCE STANDARDS
   A.  NFPA 70 – National Electric Code
   B.  NECA – National Electrical Contractor Association
1.05 QUALITY ASSURANCE
   A. Manufacturer’s Qualifications
      2. Comply with NFPA 70.

1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS
   A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
   B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   C. Rated Strength: Adequate in tension and shear force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of 3 times the applied force.

1.07 DELIVERY, HANDLING AND STORAGE (NOT USED)

1.08 MAINTENANCE / SPARE PARTS (NOT USED)

1.09 WARRANTY/EXTENDED WARRANTY
   A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of that fails in materials or workmanship within specified warranty period.
   B. Warranty Period: Two (2) years from date of Substantial Completion. Cost for the removal, shipment, repair, and installation by Contractor shall be included in warranty, as well as correction of defective work.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Support, Anchorage, and Attachment Components
      1. Outdoor, dry well, wet well use: Use stainless steel 316 components for support, anchorage and attachment components for any supports unless otherwise noted.
      2. Indoor corrosive areas use fiberglass components for support, and 316 SS anchorage and attachment components for any supports unless otherwise noted.
      3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Allied Tube & Conduit.
         b. Cooper B-Line, Inc.; a division of Cooper Industries.
         c. ERICO International Corporation.
         d. GS Metals Corp.
         e. Thomas & Betts Corporation.
         f. Unistrut; Tyco International, Ltd.
         g. Wesanco, Inc.
         h. Channel Dimensions: Selected for applicable load criteria.
      4. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
5. Conduit and Cable Support Devices: hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

6. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported.

7. Structural Steel for Fabricated Supports and Restraints:
   a. 316 Stainless Steel only for outdoor, dry well, and wet well installations.
   b. Galvanized Steel for indoor air conditioned space installations.

8. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   a. Adhesive Anchor Systems: Epoxy adhesive 316 Stainless Steel, for use in hardened portland cement concrete, with tension and shear capacities appropriate for supported loads and building materials where used.
      (i) Manufacturers: Hilti Inc. only.
   b. Mechanical-Expansion Anchors: Wedge-type 316 Stainless Steel, for use in hardened portland cement concrete, with tension and shear capacities appropriate for supported loads and building materials where used.
      (i) Manufacturers: Hilti Inc. only.
   c. Powder-Actuated Fasteners: 316 Stainless Steel stud, for use in hardened portland cement concrete, steel, or wood, with tension and shear capacities appropriate for supported loads and building materials where used.
      (i) Manufacturers: Hilti Inc. only.
   d. Concrete Inserts: 316 Stainless Steel, Slotted support system units.
   e. Clamps for Attachment to Steel Structural Elements: 316 Stainless Steel, type suitable for attached structural element.
   f. Through Bolts: Structural type, hex head, and high strength. 316 Stainless Steel
   g. Hanger Rods: 316 Stainless Steel.

9. Cast aluminum one-hole clam conduit supports are not acceptable.

2.02 FABRICATION

A. Fabricated Metal Equipment Support Assemblies
   1. Description: Welded or bolted, structural steel shapes, shop or field fabricated to fit dimensions of supported equipment.
   2. Materials: Comply with requirements in Division 5 Section "Metals" for 316 Stainless Steel/galvanized steel shapes and plates.
   3. All outdoor equipment rack shall be provided with canopy to protect the equipment for being overheated by the sun. Canopy shall extend at a minimum 1 foot in front of the equipment enclosure.

2.03 CONTROLS (NOT USED)

2.04 FACTORY TESTS (NOT USED)
PART 3 EXECUTION

3.01 DEMOLITION / PREPARATION
A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for conduit as required by NECA 1 Table 1 when the maximum spacing is less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with 316 Stainless Steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
D. Secure raceways and cables to these supports with two-bolt conduit clamps.
E. 316 Stainless Steel clamps designed for supporting single conduits may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 INSTALLATION
A. General Installation
1. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
2. All supports and fastening devices shall be stainless steel 316 unless when equipment is located in chlorine and ammonia environments in which case galvanized steel shall be utilized.
3. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 300 lb.
4. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   a. To New Concrete: Bolt to concrete inserts or Adhesive Anchor Bolt.
   b. To Masonry: Wedge type expansion anchors on hollow masonry units and expansion anchor fasteners on solid masonry units.
   c. To Existing Concrete: Adhesive Anchor System provided with lock washers and nuts shall be used in existing normal weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete slabs or wall less than 4 inches thick.
   d. Expansion Anchor Bolt can be used for concrete thickness is less than 4 inches to meet minimum
   e. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts
   f. To Light Steel: Sheet metal screws.
   g. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint wind strength and anchorage requirements.
5. Drill holes for expansion anchors in concrete at locations to avoid reinforcing bars.

B. Installation of Fabricated Metal Supports
   1. Comply with installation requirements in Division 5 Section "Metals" for site-fabricated metal supports.
   2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
   3. Field Welding: Comply with AWS D1.1/D1.1M.

C. Concrete Bases
   1. Construct concrete bases of dimensions indicated but not less than 6 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
   2. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."
   3. Anchor equipment to concrete base.
      a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      b. Install anchor bolts to elevations required for proper attachment to supported equipment.
      c. Install anchor bolts according to anchor-bolt manufacturers written instructions.

D. Mounting Stands: Field mounted disconnects, pushbutton control stations, etc. shall be mounted on steel stands as shown on the Drawings. Where clearance requirements for stands may not be maintained, the Owner's Representative may direct equipment to be wall-mounted adjacent to the drive, but in no case shall the distance from the drive motor to the control station exceed 3-ft.

3.03 INSPECTION (NOT USED)

3.04 FIELD TESTING (NOT USED)

3.05 FIELD PAINTING
   A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
      1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
   B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
   C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair coating to comply with ASTM A780.

3.06 CLEANING
   A. Remove dirt, dust, or concrete spatter from hangers and supports using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION
SECTION 26 05 33.13

CONDUIT FOR ELECTRICAL SYSTEMS

PART I  GENERAL

1.01  SCOPE OF WORK

A. This section specifies the furnishing and installation of electrical raceway systems.
   1. Conduit:
      a. Galvanized rigid steel.
      b. Liquid-tight flexible metal conduit.
      c. PVC Schedule 40 conduit.
   2. Wireways.

1.02  RELATED WORK

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

B. Other sections that may relate to the work in this section include, but are not limited to, the following:
   1. UGCs and General Requirements; Special Conditions.
   2. 26 00 00 – Electrical.

1.03  SUBMITTALS

A. Submit to the Owner’s Representative, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04  REFERENCE STANDARDS

A. The following standards shall apply as if written here in their entirety:
   1. ANSI C80.5 – American National Standard for Electrical Rigid Aluminum Conduit (ERAC).
   2. UL 1 - Safety Standard for Flexible Metal Conduit.
   3. UL 5 - Safety Standard for Surface Metal Raceways and Fittings.
   4. UL 651 - Standard for Schedule 40 and Schedule 80 Rigid PVC Conduit and Fittings.
5. UL 870 - Safety Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
6. UL
7. NFPA

1.05 QUALITY ASSURANCE (NOT USED)

1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS (NOT USED)

1.07 DELIVERY, HANDLING AND STORAGE

A. Handle and store equipment in accordance with manufacturer’s Installation and Maintenance Manuals. One (1) copy of this document shall be provided with the equipment at time of shipment.

1.08 MAINTENANCE / SPARE PARTS (NOT USED)

1.09 WARRANTY/EXTENDED WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of that fails in materials or workmanship within specified warranty period.

B. Warranty Period: One (1) year from date of shipment. Cost for the removal, shipment, repair, and installation by Contractor shall be included in warranty, as well as correction of defective work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Rigid Galvanized Conduit:
   1. Fittings: For RGS use threaded.
   2. Listing: UL.
   3. Acceptable RGS Manufacturers: Allied Tube and Conduit, Indalex, SAPA:

B. Liquid-tight Flexible Metal Conduit:
   1. Conduit: Spiral-wound, square-locked, aluminum plus a bonded outer jacket of PVC.
   2. Fittings: Compression sealed type aluminum.
   3. Listing: UL 467 for fittings.
   5. Acceptable Fittings Manufacturers: Appleton, Crouse-Hinds, Midwest, OZ/Gedney, Raco, and listed conduit manufacturer.

C. PVC Schedule 40 Conduit:
   1. Non-metallic rigid conduit made of polyvinyl chloride (PVC) manufactured in accordance with the National Electrical Code UL 651 and NEMA TC-2.
   2. Fittings shall also be non-metallic.
3. Acceptable conduit and fittings manufacturers: Allied Tube and Conduit, Prime Conduit, CertainTeed Products, Electri-Flex, Heritage Plastics Central.

D. Bushing: High impact, thermosetting, phenolic insulation; 150 degrees C; as manufactured by Appleton “BBUH”, Blackburn, or OZ Gedney type A.

E. Ground bushings: Conduit grounding bushings shall consist of an insulated throat conduit bushing with an attached aluminum set screw lug. Grounding bushing shall comply with Fed. Spec. W-F-408, UL Standards 514B and 467, and shall be Crouse Hinds Lazy Lug, O-Z Gedney or approved equal.

F. Locknuts: Stainless Steel as manufactured by Appleton.

G. Hubs
   1. Cast aluminum with broad flat surfaces with gripping teeth on both sides of conduit entry. Hub portion on exterior side of entry shall contain "O" ring for watertight seal of conduit entry. Hubs shall be Myers Hub, Appleton or Efcor.

H. Conduit through-wall and floor seal: malleable aluminum body with oversized sleeves, sealing ring, pressure clamp and rings and sealing grommet; hex head cap screw, as manufactured by OZ Gedney, type FSK.

I. Conduit drains: Conduit drains shall be Crouse Hinds ECD Universal, or approved equal.

J. Expansion Joints: Aluminum with internal grounding. Shall be provided with an external bonding jumper for conduits 4" and above. Expansion joint shall be SAXJG by Cooper Crouse-Hinds or equivalent by OZ Gedney.

K. Threaded nipples: As manufactured by Allied or Steel Duct. Conduit nipples shall have two (2) independent sets of threads. Running threads shall not be used. Utilize the conduit union when joining two (2) fixed conduits in a continuous run.

L. Escutcheons: Chrome-plated, sectional floor and ceiling plates, as manufactured by Crane No. 10.

M. Accessories: Reducers, washer, etc., shall be stainless steel.

N. Weatherheads: Weatherheads shall be threaded aluminum for threaded rigid conduit application and shall not be a clamp type. Weatherheads shall be Crouse Hinds series F, O-Z type 17 or Appleton Series F.

O. End bells: PVC as manufactured by Prime Conduit, Cantex or equal by Heritage Plastics.
B. Set conduit or sleeves in place a sufficient time ahead of concrete placement so as not to delay the work.

C. Apply sealing methods for sleeves through floors and through exterior walls, per details shown on plans.

D. Plugs or caps shall be installed before concrete placement begins.

3.02 INSTALLATION

A. Minimum Trade Size: 3/4 inch, except that 1/2-inch flexible metal conduit may be used in lengths not exceeding 72 inches for tap conductors supplying lighting fixtures and for switch legs. The minimum size for underground conduit shall be 1 1/2" inch.

B. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit.

C. Plastic coated metallic conduit lengths shall be joined with threaded metallic coupling that shall be each equipped with a 40 mil thickness sleeve that shall extend over the threads of the joined conduit. Each joint shall be watertight.

D. Conduit runs made in concrete pours or surface-mounted runs that are attached to the structure, shall be equipped with an expansion/deflection fitting where they cross an expansion joint, and at every 100 feet.

E. All conduit runs shall be watertight over their lengths of run. Slope conduits such that they drain, and install drain fitting as required to remove condensation from the conduit.

F. Install a drain fitting for all conduits subject to condensation. Condensation water shall never enter electrical or instrumentation enclosure.

G. Plastic jacketed flexible metal conduit shall be used to connect wiring to motors, limit switches, bearing thermostats, and other devices that may have to be removed for servicing. Unless otherwise indicated, maximum lengths of flex shall be thirty (30") inches.

H. Application of Conduit Types:
   1. All underground conduit including conduits under a concrete slab shall be schedule 40 PVC.
   2. Exposed conduits inside dry ventilated areas, outdoors in non-corrosive atmosphere shall be galvanized rigid steel.
   3. Exposed conduits in areas where chemicals are stored, handled, or utilized the conduit shall be PVC schedule 40.

I. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with an approved tool. Cutting openings with a torch or other device that produces a jagged, rough cut will not be acceptable.

J. Installation Requirements:
   1. Metallic Conduits:
      a. Continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc.
      b. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout.
c. Where knockouts are used, provide double locknuts, one on each side.
d. At conduit terminations, provide insulated bushings for conductor protection.
e. Where conduits terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, terminate conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.
f. Hubs of the same material shall be used at conduit termination.

2. Run concealed conduit as directly and with the largest radius bends as possible.

3. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed.

4. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas.

5. Select properly sized plates to fit the conduit when securely locked in place.

K. Installation Methods:

1. Install each entire conduit system complete before pulling in any conductors.

2. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and omissions.

3. Cut all joints square, then thread and ream smooth.

4. Bends:
   a. Make bends with standard elbows or conduit benders in accordance with the NEC.
   b. Make field bends using equipment designed for the particular conduit material and size involved.
   c. Bends must be free from dents or flattening.
   d. Use no more than the equivalent of three 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

5. Conduit bodies may be used in lieu of conduit elbows where ease of installation and appearance warrants their use. Conduit bodies larger than 1-inch may be used only where approved.

6. Fastenings: Securely fasten and support exposed conduit to framing using stainless steel unistrut and straps of same material as unistrut with 316 stainless steel fastening hardware.

7. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work, such as telephone, signal, and similar systems. Identify both ends of the line by means of labels or tags reading "Pulling Line." Also, state the panel the conduit originated from. Apply write-on identification to empty conduits to identify each conduit as to terminus of other end and also to identify trade size of conduit.

8. Suitably cap conduit during construction to avoid water, dirt and trash entrance.

9. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs of more than 100 feet or where necessary. Provide bonding jumpers across fittings in metal raceway systems. Conduit runs made in concrete pours or surface-mounted runs that are attached to the structure, shall be equipped with an expansion/deflection fitting where they cross an expansion joint, and at every 100 feet.

10. Use expansion-deflection fittings on all conduit runs that transition from underground to above ground within 12" of grade level.
11. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.

12. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall maintain the fire resistance rating using approved methods. See NEC 300-21. Fire barrier shall be 3M 2001 RW silicone RTV foam or approved equal.

13. Conduits shall be installed with uniform slope which will permit drainage toward manholes, pull boxes, or building walls. Utilize conduit drain as required to remove condensate in the conduits.

14. Seal all conduits with pliable sealant such as "Duraseal" where entering boxes, manholes, switchgear, motor control centers, panelboards, enclosures, etc.

15. PVC coated conduit shall be installed by certified installer. PVC coated conduit installation shall follow manufacturer recommendation.

16. All termination at an enclosure shall be made from the bottom of the enclosure, no overhead penetrations are allowed. When conduits are located above the enclosure route the conduit at the same height as the bottom of the enclosure, install a drip lane at the end of the conduit and use flexible conduit to terminate at the bottom of the enclosure.

3.03 INSPECTION (NOT USED)

3.04 FIELD TESTING (NOT USED)

3.05 FIELD PAINTING (NOT USED)

3.06 CLEANING

A. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation. Coordinate approval of cleanliness with the Owner’s representative.

END OF SECTION
SECTION 26 05 33.16

BOXES FOR ELECTRICAL SYSTEMS

PART I GENERAL

1.01 SCOPE OF WORK
   A. Furnish and install outlet boxes, floor boxes, junction boxes, pull boxes and terminal boxes.
   B. All boxes located outdoors containing heat sensitive equipment shall be factory painted white.

1.02 RELATED WORK
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   B. Other sections that may relate to the work in this section include, but are not limited to, the following:
      1. UGCs and General Requirements; Special Conditions.
      2. 26 00 00 - Electrical.

1.03 SUBMITTALS
   A. Submit to the Owner’s Representative, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.
   B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.
   C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.
   D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04 REFERENCE STANDARDS
   A. ANSI/NEMA Publication No. OS 1 - Cast Aluminum Outlet Boxes, Device Boxes, Covers and Box Supports, and Steel Covers.
   B. ANSI/UL 514 - Electrical Outlet Boxes and Fittings.

1.05 QUALITY ASSURANCE
   A. The general construction of the boxes and the materials used shall be similar to that used for boxes of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities. Upon request, the manufacturer shall submit a copy of his Quality Assurance Manual detailing the quality control and quality assurance measures in place at his facility.
   B. The manufacturer shall have available for audit detailed descriptions of the method by which his various manufacturing processes and production test are recorded, thus enabling the
"traceability" of the boxes. All steps in the manufacturing process, from receipt of raw material to the final tests, are to be included. Where multiple records are used, the method for cross-referencing shall be noted.

1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS (NOT USED)

1.07 DELIVERY, HANDLING AND STORAGE

A. Handle and store equipment in accordance with manufacturer’s Installation and Maintenance Manuals. One (1) copy of this document shall be provided with the equipment at time of shipment.

B. Enclosures shall be stored in the original cartons in a favorable environment (cool and dry areas).

1.08 MAINTENANCE / SPARE PARTS (NOT USED)

1.09 WARRANTY/EXTENDED WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of that fails in materials or workmanship within specified warranty period.

B. Warranty Period: One (1) year from date of shipment from the factory. Cost for the removal, shipment, repair, and installation by Contractor shall be included in warranty, as well as correction of defective work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Outlet Boxes

1. Flush Device Boxes:
   a. Provide cast aluminum boxes of sufficient size to accommodate wiring devices to be installed at outlet.
   b. Extension rings shall not be acceptable.
   c. Square or rectangular boxes may be supplied.
   d. Unless otherwise noted, provide boxes 3-1/2-inches deep by 4 inches wide.
   e. Boxes in hazardous locations shall be NEMA rated for the application.
   f. Boxes in contact with masonry or concrete shall be gray steel.

2. Exposed Device Boxes: Provide FD aluminum boxes for surface mounting in areas having exposed conduit systems. Provide gray steel boxes in areas in contact with masonry or concrete. Coordinate box cover for proper use.

3. Boxes for Lighting Fixtures:
   a. Provide aluminum octagonal boxes with fixture stud supports and attachments as required to properly support ceiling and bracket-type lighting fixtures.
   b. Unless otherwise noted, provide boxes 2 inches deep by 4 inches wide.
   c. Boxes in contact with masonry or concrete shall be grey steel.

4. Masonry Boxes:
   a. Provide stamp metal masonry boxes.
   b. Use boxes with 1-gang capacity in excess of the number of devices to be installed.
   c. Extension ring covers shall not be acceptable.

5. Listing: UL 514.

B. Junction, Pull and Splice Boxes
1. Construction: Provide boxes conforming to NEC Article 314.
2. Interior Spaces: Provide surface mounted NEMA 12 aluminum boxes at least 4 inches deep, with continuous hinged cover.
3. Exterior Spaces: NEMA 4X stainless steel type 316 boxes at least 4 inches deep.
4. Embedded: Provide stainless steel 316 type with external recessed flanged cover when cast in concrete.
5. Listing: UL 514.
7. Hazardous location: Box shall be NEMA rated for the application.
8. Chemical areas: Box shall be rated NEMA 4X, PVC or fiberglass reinforced polyester. Fiberglass enclosures shall not be used in the presence of sodium hypochlorite. Non-metallic boxes shall have UV inhibitors and shall not be mounted in direct sunlight.

C. Termination Cabinets & Boxes
1. Termination cabinets shall be NEMA 4X 316 stainless steel gasketed. Cabinets shall be of sufficient size to adequately contain all terminals, wire-duct, and cables as determined by the CONTRACTOR. Cabinets shall have removable doors (lift-off) not more than 30 inches wide and shall be equipped with a three-point locking latch handle.
2. Wire terminal blocks shall be square D type M Barrier Block system or equal.
   a. M4/6G or B 22014 AWG 6MM (0.234 inch) wide, grey blue, single level, 600 volt, 20A.
   b. M6/8G or B 22-8 AWG 8MM (0.315 inch) wide, grey blue, single level, 600 volt, 55A.
3. The wire terminal block system shall be for DIN rail mounting, and shall include fuse/switch blocks, circuit breaker block, and isolation switches.

2.02 FABRICATION (NOT USED)
2.03 CONTROLS (NOT USED)
2.04 FACTORY TESTS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION / PREPARATION
A. Coordinate location of all boxes with all other work.
B. Verify location of floor boxes with Engineer before installation.

3.02 INSTALLATION
A. Outlet Boxes
   1. Flush Boxes:
      a. Unless otherwise indicated, mount all outlet boxes flush within 1/4-inch of the finished wall or ceiling line.
b. Securely fasten outlet boxes in position using clips or other suitable means.
c. Provide plaster covers for all boxes in plastered walls and ceilings.

2. Fixture Boxes: Where boxes for suspended lighting fixtures are attached to and supported from suspended ceilings, adequately distribute the load over the ceiling support members.

3. Mounting Height:
   a. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate.
   b. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation.
   c. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall.
   d. Verify the final location of each outlet with Owner's Representative before rough-in.
   e. Remove and relocate any outlet box placed in an unsuitable location.

4. Back-to-Back Boxes:
   a. Do not connect outlet boxes back to back unless approval is obtained.
   b. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.

5. Box Openings: Provide only the conduit openings necessary to accommodate the conduits at the individual location.

B. Floor Boxes
   1. Completely envelop floor boxes in concrete except at the top. Increase slab thickness at boxes if required for bottom covering. Adjust covers flush with finished floor.

C. Junction and Pull Boxes
   1. Pull boxes and junction boxes shall be provided to facilitate the installation of cable and wires. "Conduit" type fittings shall not be used in lieu of boxes when the conduit contains wire #4 AWG or larger.

2. Installation:
   a. Install boxes as required to facilitate cable installation in raceway systems.
   b. Generally provide boxes in conduit runs of more than 100 feet.
   c. Locate boxes strategically and make them of such shape and size to permit easy pulling of wire or cables. Size boxes in accordance to NEC Article 314.28 requirements.

3. Covers:
   a. Provide boxes so that covers are readily accessible and easily removable after completion of the installation.
   b. Include suitable access doors for boxes above suspended ceilings.
   c. Select a practical size for each box and cover.

3.03 INSPECTION (NOT USED)

3.04 FIELD TESTING (NOT USED)

3.05 FIELD PAINTING (NOT USED)

3.06 CLEANING (NOT USED)

END OF SECTION
SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK
   A. Furnish and install tags/nameplate on all equipment, devices, instruments, conduit and
      conductor marking as indicated on the drawings and specified herein. Major equipment shall be
      furnished with nameplates in accordance with their individual specifications.

1.02 RELATED WORK
   A. Division 26 00 00 – Electrical.
   B. UGCs and General Requirements; Special Conditions.

1.03 SUBMITTALS
   A. Submit to the Owner’s Representative, in accordance with Division 1, detailed catalog
      information or drawings describing electrical and physical characteristics of all equipment
      specified.
   B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment
      option not provided.
   C. Literature and drawings describing the equipment in sufficient detail, including parts list and
      materials of construction, to indicate full conformance with the Specifications.
   D. Submit a letter showing all the exceptions to the specification. If no exceptions are taken the
      letter shall indicate no exception. Submittal will be rejected without preliminary review if the
      letter is not submitted.

1.04 REFERENCE STANDARDS (NOT USED)
1.05 QUALITY ASSURANCE (NOT USED)
1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS (NOT USED)
1.07 DELIVERY, HANDLING AND STORAGE (NOT USED)
1.08 MAINTENANCE / SPARE PARTS (NOT USED)
1.09 WARRANTY / EXTENDED WARRANTY (NOT USED)

PART 2 PRODUCTS

2.01 MATERIALS
   A. Wire Markers
      1. Provide heat shrinkable sleeves and machine printed legends at every conductor. Sleeves
         and legends shall be high resistant to abrasion, solvents and chemicals. Provide Tyco
         TMS, Brady Perma Sleeve XPS, or approved equal. Markers shall be white with black
         lettering.
2. Markers shall have conductor origin, termination and circuit number, terminal number whichever applies.

3. Large conductors, multi-conductor cable and tray cables to be identified with placards held on with wire ties and of the same quality as markers for smaller single conductors.

4. Cables in cable tray to be identified with place cards at the equipment and at 20 feet spans in between.

5. All control wiring in electrical equipment or manufactured supplied panel shall have wire markers.

B. Conduit Markers
   1. Exposed Conduit
      a. Conduit markers to be stainless steel type permitting embossing on the job and attached to conduit with banding made of same material. Markers to be installed lengthwise and wrapped with clear adhesive tape.
      b. Conduits to be marked at the point of origin, the point of termination, upon crossing wall, each side of junction boxes and at 20-foot internals for all exposed and accessible conduits. Identify all exposed conduits by their panel, MCC, circuit numbers or loop numbers.
      c. Provide labels for high voltage conduit. Labels shall be vinyl for indoor exposed conduit or polyester for outdoor exposed conduit. Label shall be black letters on red/orange background. Labels shall be as manufactured by Thomas and Betts or Brady.

C. Nameplates
   1. Nameplates:
      a. Externally mark electrical equipment by means of suitable nameplates identifying each and the equipment served.
      b. Provide each piece of equipment with a white phenolic nameplate with 3/16-inch-high black lettering secured to front of equipment.
      c. Supply blank nameplates for spare units and used spaces.
      d. Actual nameplate legend, which may consist of up to three lines, will be provided to the Owner's Representative on submittals.

2. Nameplate Fasteners: Fasten nameplates to equipment only by means of appropriate 316 SS screws and gasket. Stick-ons or adhesives will not be allowed. Seal opening in order to maintain the NEMA rating of the enclosure.
   a. Nameplate Information: In general, the following information is to be provided for the types of electrical equipment as listed.
   b. Switchgear, Motor Control Centers and Distribution Panelboards: On the mains, identify the piece of equipment, the source, and voltage characteristics, i.e., 480V, 3PH, 3W, etc. For each branch circuit protective device, identify the load served and the primary side circuit number.
   c. Transformers: Identify the service source and load served.
   d. Panelboards: Identify the service source, panelboard designation and voltage characteristics.

3. Panelboards:
a. Prepare a neatly typed circuit directory behind clear heat-resistant plastic for each panelboard. Directory shall include circuit identification, protective device type, trip rating, number of poles, and rating of main lugs or main circuit breaker.

b. Identify circuits by equipment served and by room numbers, where room numbers exist.

c. Use equipment names and room numbers selected by the Owner’s Representative; names and numbers may be different from those shown on plans.

d. Indicate spares and spaces with light, erasable pencil markings.

e. Provide a final set of the panel schedule in the O&M manuals.

f. Provide a CD with the file for each Panel to the Owner with the O&M manual.

4. Boxes, Small Equipment:

a. Pull boxes and similar items shall be marked with Nameplates.

b. Provide identification labels for high voltage equipment and raceways with the legend "DANGER HIGH VOLTAGE". Mark all exposed high voltage raceways every 25 feet. Safety labels shall be self-sticking polyester and as manufactured by Thomas and Betts (Panduit) or Brady.

5. Power Receptacles: Use nameplate or engraved plate to identify power receptacles where the nominal voltage between a pair of contacts is greater than 150 volts with circuit number, voltage, and phases.

6. Wall Switches: Engrave the switch plate of the switch with the function of the switch.

D. Power Outlets, Switches, and Pilot Devices

E. Mark power outlets with voltage, phase, panel name, and circuit number.

F. Identify all wall switches, disconnect switches, etc. with nametags, circuits served, and panel origin, list to be approved by Owner’s Representative/Owner.

G. Identify all push-button stations with their functions and equipment served.

H. Detectable Warning Tape

1. Shall be red metal detectable polyester with a subsurface graphics to seal the legend from acid, alkalis and other soil substances.

2. Minimum width shall be 2", and the Warning tape shall be installed 12" below grade about the duct bank or individual conduits.

3. Warning tape shall meet OSHA regulation for covering location of underground utility lines.

4. The legend shall show CAUTION: BURIED ELECTRIC LINE BELOW

5. The warning tape shall be Red with black lettering.

6. Acceptable manufacturer shall be Brady 91601 or approved equal.

2.02 FABRICATION (NOT USED)

2.03 CONTROLS (NOT USED)

2.04 FACTORY TESTS (NOT USED)
PART 3 EXECUTION

3.01 DEMOLITION/PREPARATION (NOT USED)

3.02 INSTALLATION

A. Furnish and install nameplates for all panelboards, motor starters, motor control center cubicles, disconnect switches, instrument panels, dry type transformers and control stations.

B. Engrave the equipment designation, (e.g., "Starter Pump P1"), on nameplates in 3/16-inch black letters on white background of laminated phenolic. Securely fasten nameplates using stainless steel 316 sheet metal screws or rivets; or contact cement if enclosure is sealed. All switches, indicating lights, pushbuttons, meters and parameter indicators on panels shall be clearly identified with its function or tag, as required. Identification list to be approved by owner representative through the Owner’s Representative.

C. Stainless Steel tags shall be used on instrument, motors and other devices, as applicable. The tags shall be affixed to the instrument with drive pins or stainless steel chain in such a manner that it does not need to be removed to install the instrument. Motors shall carry the tag assigned to its driven equipment, (e.g., P-101).

3.03 INSPECTION (NOT USED)

3.04 FIELD TESTING (NOT USED)

3.05 FIELD PAINTING (NOT USED)

3.06 CLEANING (NOT USED)

END OF SECTION
SECTION 26 05 60

ELECTRICAL HEAT TRACING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish labor, material, equipment, and incidentals necessary to install freeze protection system.

B. Heat Tracing: Provide heat trace as directed on plans and areas vulnerable to freezing. Heat tract shall be installed under the insulation.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Division 1, Submittal Requirements and shall include record data.

B. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

1.03 STANDARD

A. National Electric Code.

PART 2 PRODUCTS

2.01 FREEZE PROTECTION SYSTEM

A. Heat tracing shall be automatic self-regulating, UL listed, with tinned copper braid, able to crossover itself without overheating, parallel circuit design, able to be cut to length at job site, flat and flexible for easy installation, corrosion and chemical resistant, complete with power connection kits, splice kits, end seal kits and necessary accessories for a complete operating installation 120 VAC, 60 HZ, 3W/ft.

B. Cable shall be Raychem 3BTV-CT or, Chromalox or Alaska Incorporated ‘Arctic Trace’, equivalent product.

C. Thermostat Control: NEMA 4X enclosure, UL listed ambient-sensors thermostat with adjustable set point. Acceptable manufacturers and models: Tyco Digitrace AMC-1A-120V or Chromalox equivalent product.

D. Contractor to provide necessary J-Boxes, J Boxes shall be Raychem JBM-100 or Chromalox equivalent product for multiple connections and Raychem JBS-100 or Chromalox equivalent product for single connection.

E. Contractor to provide a minimum of one end seal with LED per assembly, end seal shall be Raychem E-100-L1A. LED shall be used to verify the system is on.

F. All other end seal shall be Raychem E150 or Chromalox equivalent product.

G. Tape shall be Raychem PS-10 or Chromalox equivalent product.

H. Labels shall be Raychem ETL or Chromalox equivalent product.
PART 3  EXECUTION

3.01  INSTALLATION

A. Contractor to provide and install necessary conduits and circuits per Division 26.

END OF SECTION
SECTION 26 24 16

PANELBOARDS

PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish and install distribution and branch circuit panelboards.

1.02  RELATED WORK

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

B. Other sections that may relate to the work in this section include, but are not limited to, the following:
   1. UGCCs and General Requirements; Special Conditions.
   2. 26 00 00 - Electrical.

1.03  SUBMITTALS

A. The following information shall be submitted to the Owner’s Representative:
   1. Breaker layout drawing with dimensions indicated and nameplate designation.
   2. Component list.
   3. Conduit entry/exit locations.
   4. Assembly ratings including:
      a. Short-circuit rating.
      b. Voltage.
      c. Continuous current.
   5. Cable terminal sizes.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

1.04  REFERENCE STANDARDS

A. The following standards shall apply as if written here in their entirety:
   1. UL 50 - Cabinets and Boxes.
   2. UL 67 - Electric Panelboards.
   3. NEMA AB 1 - Molded Case Circuit Breakers.
4. NEMA AB 2 - Procedures for Verifying the Performance of Molded Case Circuit Breakers.
5. NEMA KS 1 - Enclosed Switches.
6. NEMA PB 1 - Panelboards.

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. The general construction of the panelboard and the materials used shall be similar to that used for panelboards of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities. Upon request, the manufacturer shall submit a copy of his Quality Assurance Manual detailing the quality control and quality assurance measures in place at his facility.

2. The manufacturer shall have available for audit detailed descriptions of the method by which his various manufacturing processes and production test are recorded, thus enabling the "traceability" of the panelboard. All steps in the manufacturing process, from receipt of raw material to the final tests, are to be included. Where multiple records are used, the method for cross-referencing shall be noted.

B. Acceptable Manufacturers

1. General Electric.
2. Siemens.
3. Square D.

1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS (NOT USED)

1.07 DELIVERY, HANDLING AND STORAGE

A. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document shall be provided with the equipment at time of shipment.

1.08 MAINTENANCE / SPARE PARTS (NOT USED)

1.09 WARRANTY/EXTENDED WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of that fails in materials or workmanship within specified warranty period.

B. Warranty Period: One (1) years from date of Substantial Completion. Cost for the removal, shipment, repair, and installation by Contractor shall be included in warranty, as well as correction of defective work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bus

1. Material:
a. Provide tin plated, copper bus bars, 98 percent IACS conductivity, full-sized throughout their length.
b. Use buses with tin-plated contact surfaces.
c. Include a tin plated copper bus bar ground bus in panelboard rated.
d. Full size (100% rated) insulated neutral bus shall be included in the panel board, shown with neutral. 200% rated neutral bus shall be supplied for panels designated on the drawings.
e. The ground and neutral bus shall be at least one terminal screw for each circuit.
f. Provide through feed or sub feed lugs where indicated.
g. Provide lugs and connection points on phase, neutral and ground bus suitable for copper conductors.
h. Spaces for future circuit breakers shall be bussed for the maximum devices that can be fitted.

2. Size bars as indicated and brace them to withstand the available symmetrical short circuit current.

3. Installation:
   a. Install buses in allotted spaces so that devices can be added without additional machining, drilling or tapping.
   b. Mount neutral bars, as required, on the opposite end of the main lugs.

B. Protective Devices

1. Circuit Breakers: Provide circuit breakers for the specified service with the number of poles and ampere ratings indicated.
   a. Provide breakers which are quick-make and quick-break on both manual and automatic operation.
   b. Use a trip-free trip indicating breaker.
   c. Incorporate inverse time characteristic by bimetallic overload elements and instantaneous characteristic by magnetic trip. Where indicated, provide ground fault circuit breakers (GFCB).
   d. For 2-pole and 3-pole breakers, use the common-trip type so that an overload or fault on one pole will trip all poles simultaneously. Handle ties are not acceptable.
   e. Unless otherwise indicated, provide circuit breakers with the following interrupting ratings:
      (i) Each circuit breaker used in 120/208 Volt panelboards shall have an interrupting capacity of not less than 22,000 Amps, RMS symmetrical.
      (ii) Each circuit breaker used in 277/480 Volt and 480 Volt panelboards shall have an interrupting capacity of not less than 42,000 Amps, RMS symmetrical.
      (iii) GFCI (ground fault circuit interrupter) shall be provided for circuits where shown on the drawings. GFCI units shall be 1 Pole, 120 Volt, molded-case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and an interrupting capacity of 10,000 Amps, RMS.
      (iv) Circuit breakers shall be as manufactured by the panelboard manufacturer.
   f. Connect breakers to the main bus by means of a solidly bolted connection.
   g. Use breakers which are interchangeable, capable of being operated in any position within the panel.
h. Each panelboard shall be equipped with a minimum of 20 percent spare breakers, with spaces, bus work, and terminators to complete the next standard size panelboards above the 20% requirement.

i. Independently mount breakers so that a single unit can be removed from the front of the panel without disturbing or removing the main bus, other units or other branch circuit connections.

j. Provide individual breaker handle lock for all circuits that supply exit signs, emergency lights, and fire alarm panels.

k. Provide GFI circuit breakers for heat trace circuit. The rating shall be as per NEC.

2. Surge Suppressor
   a. All panelboards shall be provided with a surge protective device in accordance with Specification 26 43 13 unless otherwise indicated on the drawings.

3. Service Entrance
   a. The panelboard shall have a connection for housing and grounding neutral conductor.
   b. Provide a UL label for the panelboard.

2.02 FABRICATION

A. Enclosure
   1. Cabinet:
      a. Construct cabinets in accordance with UL 50. Use painted galvanized sheet steel 16-gauge or more.
      b. Provide a minimum 4-inch gutter wiring space on each side.
      c. Reinforce cabinets and securely support bus bars and over-current devices to prevent vibration and breakage in handling.
      d. Provide standard conduit knockouts in cabinet ends.
      e. Finish cabinets of surface-mounted panelboards to match doors and trim as specified below.
      f. Panelboards mounted outdoors shall be weatherproof, and shall have a door behind door type construction.
      g. Panelboards mounted outdoor in wet or corrosive areas shall have NEMA 4X stainless steel 316 enclosures.
      h. Panelboards mounted indoor shall be NEMA 12 enclosures for areas classified as NEMA 12.

2. Doors and Trim:
   a. Fabricate doors and trim from cold-rolled sheet steel.
   b. Equip doors with flush-type combination catch and key lock.
   c. Key all locks alike. Fasten trim for flush-mounted panelboards to cabinets by an approved means which permits both horizontal and vertical adjustment.
   d. Trim for surface-mounted panelboards must fit the cabinet with no overhang.
   e. Apply a finish to trim and doors consisting of two coats of enamel over a rust-inhibiting prime coat.

B. Circuit Identification
   1. Directory:
      a. For each panelboard, provide a directory frame mounted inside the door with a heat-resistant transparent face and a directory card for identifying the load served.
b. Type directory as specified in Section 26 05 53.

2. Nameplate:
   a. Provide a black on white phenolic nameplate on the face of the panelboard using the following as an example:

   Panel EH1
   277/480V, 30, 4W
   Feeder from Switchboard/Section

   b. The nameplate shall have a minimum thickness of 1/8" and be mounted above the panel door.

C. Listing
   1. UL 67 - Electric Panelboards.

D. Special Requirements
   1. All copper items, including wiring, terminal blocks, lugs, connectors, bus, etc., shall be tin plated copper.
   2. All steel shall be primed and painted as specified. Galvanized items shall also be painted.
   3. All hardware, including nuts, bolts, washers, screws, anchor bolts, door hinges, etc., shall be made of 316 stainless steel.
   4. The panelboard steel parts shall be cleaned and sprayed in control cleaning solutions by a multi-stage spray washer. The operation shall produce a coating of a minimum of 150 milligrams per square foot to meet MIL Specification TT-C490. The primed metal parts shall be electrostatically coated with power paint to a thickness of 2.5mils. The paint finish shall withstand a minimum of 1000 hours salt spray test.

2.03 CONTROLS (NOT USED)

2.04 FACTORY TESTS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION/PREPARATION (NOT USED)

3.02 INSTALLATION

A. Install panelboards in the locations as shown and as recommended in NEMA PB1.1.

B. In wet and corrosive areas, including outdoor locations, install stainless steel 316 panelboard enclosures on Type 316 stainless steel unistrut support to provide clearance behind the mounting surface.

C. In wet and corrosive areas, including outdoor locations, connect conduits to the bottom of the enclosure and to the lower 30 percent of the sides.

D. All conduit connections shall be by use of Myers hub.

E. Install the panelboards such that the center of the switch or circuit breaker in the highest position will not be more than 6-1/2 feet above the floor or working platform.

3.03 INSPECTION

A. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacturer’s recommendations.
B. Check all installed panels for proper grounding, fastening and alignment.

3.04 FIELD TESTING (NOT USED)

3.05 FIELD PAINTING
   A. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.06 CLEANING
   A. Remove debris from installation site and wipe dust and dirt from all components.

END OF SECTION
SECTION 26 24 18
COMMON CONTROL PANEL
REQUIREMENTS FOR EQUIPMENT

PART I  GENERAL

1.01  WORK INCLUDED

A. Furnish and install a functional control panel to operate the control system as specified in the
detailed mechanical equipment requirements of this Section.

B. Obtain all required control descriptions and data from the detailed mechanical equipment
requirements to this Section, the System Description and the control schematic diagrams on the
Electrical Contract Drawings.

C. Provide control system engineering to produce custom elementary drawings showing
interwiring and interlocking with remote devices.

D. All control devices, unless specified otherwise, shall be mounted in the control panel.

E. This section includes control panels supported by equipment manufacturers to manually or
automatically operate the mechanical equipment.

1.02  REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers (IEEE)

B. National Electrical Manufacturers Association (NEMA)

C. Underwriters Laboratories (UL)

D. Where reference is made to one of the above standards, the revision in effect at the time of bid
opening shall apply.

1.03  SUBMITTALS

A. Submit to the Engineer, in accordance with Division 1, shop drawings and product data for the
following:

1. Equipment outline drawings showing elevation, plan and interior views, front panel
arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt
pattern. Indicate all options, special features, ratings and deviations from this Section.
Furnish complete Bill of Materials indicating manufacturer's part numbers.

2. Power and control schematics including external connections. Show wire and terminal
numbers and color coding.

3. Instruction and replacement parts books.

4. Certified shop test reports.

5. As-built final drawings.

6. Field tests and inspection reports.

B. Literature and drawings describing the equipment in sufficient detail, including parts list and
materials of construction, to indicate full conformance with the Specifications.
1.04 QUALITY ASSURANCE
   A. A factory authorized service and parts organization shall be able to respond to any service call for the project within 8 hours. Provide the name and address of the factory authorized service and parts organization nearest to the project location at the time of the bid.
   B. Equipment components and devices shall be UL labeled to the extent possible wherever UL standards exist for such equipment.
   C. The control panel manufacturer shall demonstrate at least three years of continuous field operating experience in control panel design and fabrication. Submit customer/user list with telephone numbers, addresses and names of customer/user representatives.

1.05 SYSTEM DESCRIPTION
   A. Refer to the detailed mechanical equipment specifications for description of system operation.

1.06 DELIVERY, STORAGE AND HANDLING
   A. Package the control panel for maximum protection during delivery and storage.
   B. Store the control panel indoors in a clean, dry, heated storage facility until ready for installation. Do not install the control panel in its final location until the facilities are permanently weather tight. Protect the control panel at all times from exposure to moisture, chemicals, hydrogen sulfide and chlorine gas.

1.07 PROJECT/SITE REQUIREMENTS
   A. The control panel shall consist of a main circuit breaker, a combination motor circuit protector (MCP), magnetic starter and overload relay for each motor, a 120 volt control power transformer with two fuses on the primary and one fuse on the secondary. All control components shall be mounted in one common enclosure. Control switches shall be provided to operate each motor either manually or automatically.

1.08 WARRANTY
   A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for a period no less than the controlled equipment warranty.

PART 2 PRODUCTS

2.01 RATING
   A. The control panel shall operate on a power supply as indicated on drawings.
   B. The overall withstand and interrupting rating of the equipment and devices shall not be less than 42,000 amperes R.M.S, symmetrical at 480 Volts. All circuit breakers and combination motor starters shall be fully rated for the above fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.
   C. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels.
   D. The control panel shall meet all applicable requirements of the National Electrical Code.
   E. The control panel enclosure shall be in accordance with the electrical area classification indicated on the Electrical Contract Drawings.
2.02 COMPONENTS

A. The main circuit breaker shall be a thermal-magnetic molded case breaker, Type HCL. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position.

B. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.

C. Motor starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases.
   1. Motor starters shall be 2 or 3 Pole, 1 or 3-phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing except as shown on the drawings. NEMA sizes shall be as required for the horse power shown on the drawings.
   2. Each motor starter shall have a 120 Volt operating coil and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the drawings. A minimum of one N.O. and N.C. auxiliary contacts shall be provided in addition to the contacts shown on the drawings.
   3. Overload relays shall be adjustable ambient compensated and manually reset.
   4. Control power transformers shall be sized for additional load where required. Transformer primaries shall be equipped with time-delay fuses.

D. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein, as required by the detailed mechanical equipment requirements, Division 26 and as shown on the Drawings.

E. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Electrical Drawings.
   1. Indicator lamps shall be heavy duty, 30 mm industrial type oil light, NEMA 4X, high-visibility LED, full voltage type. Units shall have screw on plastic lenses and shall have factory engraved legend plates as required. Unless otherwise specified in each equipment specification lens color shall be green for equipment OFF, red for equipment operating, blue for FAIL or ALARM and amber for power ON/Equipment Stand-by. For all control applications, indicator lamps shall incorporate a push-to-test feature.
   2. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, MOTOR SELECTOR, LEAD-LAG, etc) shall be heavy-duty 30 mm, NEMA 4X, oil tight, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.
   3. Push-button, shall be heavy-duty, 30 mm, NEMA 4X, oil tight industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Button color shall be red for EMERGENCY STOP or START and green for STOP. Contact arrangement shall be as required.

F. A six digit, non-resettable elapsed time meter shall be connected to each motor starter.
A failure alarm with horn and beacon light shall be provided as required by contract document. Silence and reset buttons shall be furnished.

The control panel shall be provided with a Surge Protective Device Unit on the load side of the main circuit breaker. Surge Protective Device shall be rated 65Ka per mode for all unit rated for 480V located outdoor. Provide a surge capacitor for all the 120 panels located outdoors.

All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250 VAC and 10 Amps continuous.

An alternator shall be provided to sequence motors as required by contract document.

Intrinsically safe relays shall be solid state type with 5 Amp output contacts, suitable for use on a 120 Volt, 60 Hz power supply and shall be Factory Mutual approved for pilot devices in Class I, Division 1, Group D hazardous atmospheres.

Control relays and timers shall be 300 Volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 Amps resistive, 1/4 Hp, at 120 VAC, with an operating temperature of minus 10 to plus 55 degrees C.

Panel mounted timers shall be flush mounted, plug-in type with ranges as shown on the Drawings, or as required by the detailed mechanical equipment specifications and Division 17.

Specific control devices, control descriptions and other data are specified under the detailed specification for the mechanical equipment with which the control panel is supplied.

2.03 ENCLOSURE TYPES

A. The control panel specified herein shall be rated NEMA 4X enclosures shall be 316 stainless steel.

B. Steel enclosures shall be 14 gauge and constructed with continuously welded seams. The panel door(s) shall have continuous hinge and neoprene gasket. Door clamps shall be provided.

C. The enclosure shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs. The enclosure door shall be interlocked with the main circuit breaker by a door mounted operating mechanism. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

D. Print storage pockets shall be provided on the inside of the panel.

E. Overload tables shall be laminated and adhered to the inside of the door.

F. Enclosures located outdoors shall be painted white in the factory.

2.04 NAMEPLATES MARKINGS AND IDENTIFICATION

A. Provide 2-in by 5-in, nominal, engraved phenolic master nameplate on the control panel fastened with stainless steel type 316 screws or rivets. Nameplate shall be black with white core, 3/8-in high lettering and shall indicate equipment designation as shown on the Drawing.

B. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights and meters.

C. Provide permanent warning signs as follows:
1. "Danger- High Voltage- Keep Out" on all doors.
2. "Warning- Hazard of Electric Shock - Disconnect Power Before Opening or Working On This Unit" on main power disconnect.

2.05 CONDENSATION HEATERS
A. A strip heater shall be mounted inside the control panel.
   1. Heater shall be rated 240V, but operated at 120V, single phase, 150 watts, with rust resisting iron sheath.
   2. A control thermostat mounted inside the control Panel.
   3. The strip heater terminals shall be guarded by a protective terminal cover.
   4. High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation.

2.06 WIRING
A. Power and control wire shall be 600 Volt class, Type XHHW-2 insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover.

B. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks.

C. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.

2.07 TERMINAL BLOCKS
A. Terminal blocks shall be one-piece molded plastic blocks with screw type terminals and barriers rated for 600 volts. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.

B. Wires shall be terminated to the terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated.

C. Provide an AC ground bar bonded to the panel enclosure (if metal) with 20 percent spare terminals.

D. Provide an intrinsically safe ground terminal bar isolated from the control panel enclosure. Provide 20 percent spare terminals but not less than two spare terminals.

E. Terminal points for current transformer leads shall be provided with a shorting bar.

2.08 SHOP TEST
A. Perform manufacturer's standard production testing and inspection in accordance with NEMA and ANSI standards.
PART 3 EXECUTION

3.01 INSTALLATION

A. Repaint any damage to factory applied paint finish using touch-up paint furnished by the control panel manufacturer.

B. Any work not installed according to the Drawings and this Specification shall be subject to change as directed by the Engineer. No extra compensation will be allowed for making these changes.

3.02 FIELD TESTING

A. Check mechanical interlocks for proper operation. Make any adjustments required.

B. Adjust motor circuit protectors and voltage trip devices to their correct settings.

C. Install overload heaters per actual motor nameplate currents.

D. Adjust motor circuit protectors for actual motor nameplate currents.

E. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Engineer and the control panel manufacturer’s factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

END OF SECTION
SECTION 26 27 26

WIRING DEVICES

PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish and install complete lighting and receptacle systems, including lighting fixtures, receptacles, switches, and all accessories and appurtenances as shown on the drawings and as specified herein.

1.02  RELATED WORK

A. Division 26 – Electrical

B. UGCs and General Requirements; Special Conditions.

1.03  SUBMITTALS

A. Submit shop drawings showing complete construction details for all equipment in compliance with Division 1 - General Provisions.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

D. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

1.04  REFERENCE STANDARDS

A. Wiring Devices shall be in compliance with the National Electrical Code, and shall be constructed in compliance with the Underwriters' Laboratories and shall be Underwriters' Laboratories labeled.

1.05  QUALITY ASSURANCE (NOT USED)

1.06  SYSTEM DESCRIPTION / DESIGN REQUIREMENTS (NOT USED)

1.07  DELIVERY, HANDLING, AND STORAGE (NOT USED)

1.08  MAINTENANCE / SPARE PARTS (NOT USED)

1.09  WARRANTY/EXTENDED WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of that fails in materials or workmanship within specified warranty period.
B. Warranty Period: One (1) year from date of shipment from the factory. Cost for the removal, shipment, repair, and installation by Contractor shall be included in warranty, as well as correction of defective work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Switches:
   1. Wall switches shall be of the heavy-duty specification grade, toggle action, and flush mounting quiet type.
   2. Wall switches shall be of the following types and manufacturer, or equal.
      d. Momentary Contact, 2 Circuit, Center Off: Arrow-Hart, Catalog No. 1895I, or Pass and Seymour 1250-I, or Leviton 1256-1.
      e. Weatherproof switch covers shall be Crouse-Hinds rain-tight Type DS with PVC coating where used with aluminum.
      f. Lock out attachment when used for instrument disconnect shall be NEMA 4X.
   3. Switch to be installed in classified area shall be rated for application per NEC 500.

B. Receptacles:
   1. Wall receptacles shall be 120 volts, single-phase, single or duplex, industrial specification hospital grade, and be of the following types:
      d. Weatherproof cover for GFCI receptacle in FS box while in use: Leviton 5997 GY.
      e. Computer or computer related equipment: Leviton 8380IG, or Pass and Seymour, Catalog No. IG6362ISP, ivory with translucent surge suppressor, 5-20R, 20A, 125V duplex hospital grade with audible alarm.
   2. Receptacles listed as weatherproof shall be provided with a watertight back box and hinged cover.
   3. Receptacles to be installed in classified area shall be rated for the application per NEC 500.

C. Safety Switches
   1. Safety Switches shall be of heavy duty, specification grade. Provide fuses when shown on the drawings or required to meet the short circuit current rated of the electrical system.
   2. Switch shall be UL listed.
   3. Switch shall be NEMA 4X 316 SS when located outdoors and in dry wells.
4. Switch shall be NEMA 4X fiberglass when located in a chemical room.
5. Switch shall be NEMA 12 when located indoor in a controlled environment unless otherwise noted.
6. Switch located in classified area shall be rated for the application per NEC 500.
7. Switch shall be quick-make, quick-break construction.
8. Operating handle shall be of box mounted type that directly drives the switch mechanism suitable for padlocking in the off position with up to three padlocks. Switch shall be interlock defeat.
9. The interior shall be easily removable. The wiring gutter shall be clear of any obstructions and moving parts.
10. Fusible switch, fuse selection shall be rated for the application, minimum KAIC rating shall match the protective device on the line side of the switch.
11. Switch shall be provided with grounding kit.
12. Mount safety switches 48" above finished floor. No safety switches shall be mounted above a height that requires a ladder for access.

2.02 FABRICATION (NOT USED)
2.03 CONTROLS (NOT USED)
2.04 FACTORY TESTS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION / PREPARATION (NOT USED)
3.02 INSTALLATION

A. Wiring devices must be operating properly at final completion.
B. Provide hangers and support members for wiring devices as required for proper installation.
C. Provide appurtenances which include stud supports, stems, mounting brackets, frames, and plaster rings.
D. Support wiring devices from the building structure, or from furring channels. Furring channels must be a minimum of 1-1/2 inches wide.
E. Receptacle and Switch Installation:
   1. Mounting Heights (from the bottom of the device):
      a. Mount receptacles 48 inches above finished floor except finished indoor areas.
      b. Mount outdoor receptacles at least 24 inches above finished grade.
      c. Mount receptacles in control room 12 inches above finished floor.
      d. Mount all wall switches 54 inches above finished floor.
      e. Mount thermostats 60 inches above floor.
   2. Boxes:
      a. Finished areas such as offices: Flush mounted devices in aluminum boxes.
      b. Other areas: Surface mounted cast aluminum metal boxes.

4. Install receptacles with grounded blade up.

5. Switches and receptacles shall be mounted in 4” x 4” aluminum outlet boxes concealed in the office walls.

6. Indoor and outdoor boxes shall be grounded by use of a No. 12 green insulated ground wire run with the wiring per Division 26 specification.

3.03 INSPECTION (NOT USED)

3.04 FIELD TESTING

   A. All GFCI outlets shall be tested per industry standard practices and manufacturer’s recommendations.

3.05 FIELD PAINTING (NOT USED)

3.06 CLEANING

   A. Remove debris from installation site and wipe dust and dirt from all components.

END OF SECTION
SECTION 26 28 16
MISCELLANEOUS EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

1.02 REFERENCE STANDARDS

A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Division 16.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.

B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

C. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the Specifications.

D. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

PART 2 PRODUCTS

2.01 MATERIALS

A. Control Stations

1. Control stations shall be heavy-duty type, with full size operators. Momentary contact stop buttons shall have a lockout latch that can be padlocked in the open position. Provide an extra contact to monitor the auto position of the switch as shown on the drawings.

2. NEMA 4X enclosures shall be 316 stainless steel unless when located in chemical areas where it shall be PVC or fiberglass reinforced polyester. Fiberglass enclosures shall not be used in the presence of sodium hypochlorite.

3. NEMA 7 enclosures shall be copper free cast aluminum.

4. Control stations shall be Allen-Bradley or approved equal.

B. Wireway

1. NEMA 4X wireway shall be stainless steel with gasketed, hinged covers and stainless steel type 316 screws.

2. NEMA 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co. or approved equal.

C. Control Relays
1. Control relays shall be heavy duty machine tool type, with 10 Amp, 300 Volt convertible contacts. Number of contacts and coil voltage shall be as shown on the Drawings. General use relays shall be General Electric Co., Catalog No. CR120B, similar by Square D Co.; Allen-Bradley Co. or equal. Latching relays shall be General Electric Co., Catalog No. CR120BL, similar by Square D Co.; Allen-Bradley Co. or approved equal.

2. Time delay relays shall be pneumatic, 600 Volt, 20 Amp contacts, with calibrated knob operated adjustment. On delay and off delay types and timing ranges shall be as shown on the Drawings. Relays shall be Agastat Model 7012 or 7022 or approved equal.

D. Terminal Blocks
1. Terminal blocks shall be 600 Volt, channel mounted, with tubular screw and pressure plate.
2. Terminal blocks shall be Bulletin 1492 as manufactured by the Allen-Bradley Co. or approved equal.

E. Intrinsically Safe Relays
1. Intrinsically safe relays shall be solid state type with 5 Amp output contacts, suitable for use on a 120 Volt, 60 Hz power supply and shall be FM approved for pilot devices in Class I, Division 1, Group D hazardous atmospheres.
2. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or approved equal.

F. JIC Boxes for GF Receptacles
1. Furnish all necessary hardware for mounting the heat tape and thermostat.
2. JIC boxes shall be 6-in by 6-in by 4-in aluminum continuous hinge clamp cover boxes, Hoffman, Catalog No. A-606 CHAL with Type L23 stainless steel type 316 fast operating JIC clamp or approved equal.
3. Install 1-1/2-in bushings in bottom of box for cord and plug to pass through.

G. On-Delay, Off-Delay Timers (Solid State)
1. On and off delay timers shall be microprocessor based, solid state type.
2. Timers shall have the following features:
   a. Adjustable timing ranges from 0.1 seconds to 99 hours, 59 minutes minimum.
   b. Setpoints entered by pressing membrane covered keyboard on unit.
   c. LCD readout of timing progress and setpoint.
   d. Adjustable for on-delay or off-delay modes.
   e. Standard sized plug-in case.
   f. Totally sealed face plate.
   g. Sealed battery backup power to retain memory for up to 30 days.
   h. Accuracy plus or minus 0.01 second.
   i. DPDT isolated instantaneous and timed output contacts rated 6 Amps minimum at 120 Volt.
3. Timers shall be Bulletin 651 Multirange, solid state as manufactured by Tenor Co., Inc.; Eagle Signal, CS-300 Series or approved equal.
H. Corrosion Inhibitors
   1. All equipment enclosures, terminal boxes, etc, located in a NEMA 4X rated area (where shown on the Drawings) that contains electrical or electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.
   2. The corrosion inhibitor pads shall be as manufactured by Hoffman Engineering Co.; 3M or approved equal.

I. Instrumentation Disconnect Switches: Provide a heavy-duty single pole disconnect toggle switch in a weather proof cast enclosure for all field instruments served with electric power. This feature shall be included whether or not shown on drawings.

J. Fuses, 0 to 600 Volts
   1. Provide a complete set of current-limiting fuses wherever fuses are indicated. Supply a set of six (6) spare fuses of each type and each current rating installed. Utilize fuses that fit mounting specified
      a. For 0 to 600 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1 with time delay, Bussmann Type LPS-RK, Shawmut Type A6D-R, or equal.
      b. For 0 to 250 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1, Bussmann Type LPN-RK, Shawmut type A2D-R, or equal.
      c. For 0 to 600 volt feeder and service circuits, 0 to 600 amps, UL Class RK-1, Bussmann Type KTS-R, Shawmut Type A6K-R, or equal.
      d. For 0 to 250 volt feeder and service circuits, 0 to 600 amps, UL Class Rd-1, Bussmann Type KTN-R, Shawmut Type A2K-R, or equal.
      e. For 0 to 600 volt feeder and service circuits, 601 to 6,000 amps, UL Class L, Bussmann type KRP-C, Shawmut Type A4BY, or equal.

K. Indicating Lights
   1. Indicator lamps shall be heavy duty 30mm, industrial type oil tight, high-visibility LED, transformer type. Units shall have screw on plastic lenses and shall have factory engraved legend plates as required. Unless otherwise specified in each equipment specification lens color shall be green for equipment OFF, red for equipment operating, blue for FAIL or ALARM and amber for power ON/Equipment Stand-by. For all control applications, indicator lamps shall incorporate a push-to-test feature.

L. Selector Switches
   1. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, MOTOR SELECTOR, LEAD-LAG, etc) shall be heavy-duty 30mm, oil tight, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.

M. Push Buttons
   1. Push-button, shall be heavy-duty, industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Button color shall be red for EMERGENCY STOP or START and green for STOP. Contact arrangement shall be as required.
N. Combination starters:

1. Combination starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Combination Starter is applicable for single motor starter only, refer to common control panel specification for other application.

2. Motor starters shall be 2 or 3 Pole, 1 or 3-phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing except as shown on the drawings. NEMA sizes shall be as required for the horse power shown on the drawings.

3. Each motor starter shall have a 120 Volt operating coil and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the drawings. A minimum of one N.O. and N.C. auxiliary contacts shall be provided in addition to the contacts shown on the drawings.

4. Overload relays shall be adjustable ambient compensated and manually reset.

5. Control power transformers shall be sized for additional load where required. Transformer primaries shall be equipped with time-delay fuses.

6. Switches, relays, push buttons shall be as specified under this section.

7. Provide additional protection as shown on contract drawing.

8. Enclosures shall be NEMA 3R and NEMA 4X for outdoor application and NEMA 12 for indoor application.

PART 3 EXECUTION – NOT USED

END OF SECTION
SECTION 26 43 13

SURGE PROTECTIVE DEVICES

FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section includes surge protective devices (SPDs) for low-voltage power equipment.

1.02 RELATED WORK

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

B. Other sections that may relate to the work in this section include, but are not limited to, the following:
   1. UGCs and General Requirements; Special Conditions.
   2. 26 00 00 – Electrical.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:
   1. UL 1283 - Electromagnetic.

C. Qualification Data: For testing agency.

D. Field quality-control test reports, including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

E. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.

1.04 REFERENCE STANDARDS

A. The surge protective devices referenced herein shall be designed and manufactured according to the following standards.
   1. UL 1283 – Electromagnetic Interference Filters.


1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm with at least 5 years of experience in manufacturing transient voltage suppressors.

B. Manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar equipment for a minimum period of (10) years. When requested by the Owner’s Representative, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 SYSTEM DESCRIPTION / DESIGN REQUIREMENTS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner’s Representative not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner’s Representative’s written permission.

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.

2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

3. Humidity: 0 to 85 percent, non-condensing.

4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.07 DELIVERY, HANDLING AND STORAGE

A. Handle and store equipment in accordance with manufacturer’s Installation and Maintenance Manuals. One (1) copy of this document shall be provided with the equipment at time of shipment.

B. Each internally mounted SPD shall be delivered fully assembled and installed as part of the associated electrical equipment.
1.08 MAINTENANCE / SPARE PARTS (NOT USED)

1.09 WARRANTY/EXTENDED WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within ten years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Siemens.
   3. Square D.

2.02 480V SWITCHGEAR, SWITCHBOARD, AND 480V MCC SUPPRESSORS

A. Surge Protective Devices with the following features and accessories:
   1. Manufactured by the Switchgear, Switchboard, or MCC manufacturer and factory installed.
   2. Fabrication using bolted compression lugs for internal wiring.
   3. Integral disconnect switch.
   4. Redundant suppression circuits.
   5. Redundant or replaceable modules.
   6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
   7. Arrangement with wire connections to phase buses, neutral bus, and ground buses.
   8. LED indicator lights for power and protection status.
   9. Audible alarm, with silencing switch, to indicate when protection has failed.
   10. One set of dry contacts rated at 5 A and 250Vac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
   11. Surge-event operations counter.
   12. Per UL96A service entrance SPD’s shall have a nominal discharge current (In) rating of 20kA.


C. Connection Means: Permanently wired.

D. Protection modes and UL 1449 Voltage Protection Rating (VPR) for grounded wye circuits with voltages of 480Y/277, 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: 1200V
2. Line to Ground: 1200V
3. Neutral to Ground: 1200V

2.03 PANELBOARD SUPPRESSORS

A. SPD with the following features and accessories:
   1. Manufactured by the Panelboard manufacturer and installed internal to the Panelboard.
   2. Fuses, rated at 100-kA interrupting capacity.
   3. Fabrication using bolted compression lugs for internal wiring.
   4. Integral disconnect switch.
   5. Redundant suppression circuits.
   6. Redundant replaceable modules.
   7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   8. LED indicator lights for power and protection status.
   9. Audible alarm, with silencing switch, to indicate when protection has failed.
   10. One set of dry contacts rated at 5 A and 250Vac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
   11. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 100 kA per mode

2.04 ENCLOSURES

A. Install surge protective devices in the same cabinet as the MCC, switchboard, and 480V panelboard, MCC, and switchgear.

PART 3 EXECUTION

3.01 DEMOLITION / PREPARATION (NOT USED)

3.02 INSTALLATION

A. Surge protective devices shall be installed by the MCC and panelboard manufacturer at the factory.

B. Do not energize or connect service entrance equipment, panelboards, control terminals, data terminals to their sources until surge protection devices are installed and connected.

C. Firestop caulk SPD connections.

3.03 INSPECTION

A. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture’s recommendations.

3.04 FIELD TESTING

A. Check all installed panels for proper grounding, fastening and alignment.

B. Remove and replace malfunctioning units and retest.
C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices.

3.05 FIELD PAINTING (NOT USED)

3.06 CLEANING (NOT USED)

END OF SECTION
SECTION 26 50 00

LIGHTING

PART I  GENERAL

1.01  SCOPE OF WORK
   A.  Furnish all labor, materials, equipment and incidentals required and install a complete LED lighting system ready for operation as shown on the Drawings and as specified herein.

1.02  RELATED WORK
   A.  UGCs and General Requirements; Special Conditions.
   B.  Section 26 00 00 - Electrical.
   C.  Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.03  SUBMITTALS
   A.  Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein.
   B.  Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned un-reviewed.
   C.  Manufacturer's technical information for the materials proposed for use in the systems.
   D.  For all light pole foundations shown to be installed in earth, provide installation and anchoring drawings that are stamped and sealed by a licensed engineer in the state of installation. The soil condition shall be assumed to be disturbed earth. If compaction is assumed, a compaction test shall be performed on all foundation locations, showing the minimum field density assumed in the foundation design.
   E.  Submit manufacturer's name and catalog data for all lighting equipment specified in this Section and on the lighting fixture schedule.
   F.  Shop drawings:
      1.  Clearly indicate luminaire type and name of the job. Contractor shall endeavor to submit all luminaires, drivers and integral controls shop drawings at one time, in one package. Any re-submittals shall include all luminaire, driver and integral controls previously rejected or requiring further information. Specialty SSL, custom, or modified fixtures may be submitted as a separate package.
      2.  Reproductions of the contract drawings are not acceptable as shop drawing.
      3.  Indicate any dimensions and components for each luminaire that are not a standard product of the manufacturer.
   G.  Product Data: Provide dimensions, ratings and specific catalog number and identification of items and accessories and performance data.
   H.  Wiring Diagrams – as needed for special operation or interaction with other system(s)
I. Photometric Data: Where indicated below or for substitutions, supply complete photometric data for the fixture, including optical performance, rendered by NVLAP approved laboratory developed according to the methods of the Illuminating Engineering Society of North America. Submit electronically, in IESNA LM-63 standard format. Types XX and YY.

J. Submit photometric data for all substitute luminaries. Photometric reports are not required from specified manufacturer unless noted in Paragraph H above.

K. Specification Sheets: If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer's complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications necessary to meet the requirements of the contract documents.

L. Substitutions shall include complete photometric data as outlined in paragraph H above, and point by point calculations for the specific conditions on the project prepared by an NCQLP or a Professional Engineer licensed in the state of installation. Samples shall be required for consideration of any substitutions and must be submitted in accordance with the terms outlined in paragraph below.

M. Working Samples of all substitutions: Samples shall be 120 volt with cord and plug attached, and shall include specified LEDs and all modifications necessary to meet the requirements specified in the Contract Documents.

N. Energy Efficiency:
   1. Submit documentation for Energy Star qualifications for equipment provided under work of this Section.
   2. Submit data indicating luminaire efficiency.
   3. Submit data indicating Ballast Efficacy Factor (BEF).
   4. Submit data indicating Luminaire Efficacy Rating (LER).
   5. Submit data indicating color rendition index of light source.

O. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

P. Manufacturer's technical information for the materials proposed for use in the systems.

1.04 REFERENCE STANDARDS

A. All lighting fixtures shall be in accordance with the National Fire Protection Association (NFPA) NFPA 70 “National Electrical Code” (NEC), and shall be constructed in accordance with the latest edition of the Underwriters Laboratories (UL) "Standards for Safety, Electric Lighting Fixtures".


C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.

D. IESNA LM-79-08 IESNA - Approved Method for Electrical and Photometric

E. Measurements of Solid-State Lighting Products.
F. IESNA LM-80-08 IESNA - Approved Method for Measuring Lumen Maintenance of LED Light Sources.

G. IESNA LM-80-08 IESNA - Approved Method for Measuring Lumen Maintenance of LED Light Sources.

H. IESNA TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources.

I. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products.

J. OSHA 29CFR1910.7 – luminaires shall be listed by national recognized testing laboratory approved by United Stated Department of Labor, Occupational Safety and Health Administration (OSHA).

1.05 QUALITY ASSURANCE

A. The luminaires shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of the modules built to meet this specification. These tests shall include: CCT, CRI, Lumen output and wattage. Tests shall be recorded, analyzed and maintained for future reference.

B. QA process and test results documentation shall be kept on file for a minimum period of seven years.

C. LED luminaire designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.

1.06 SYSTEM DESCRIPTION/DESIGN REQUIREMENTS (NOT USED)

1.07 DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Protect equipment during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.

C. Protect damaged painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to the satisfaction of the Owner/Engineer.

D. Equipment shall be installed in its permanent location shown on the Drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor’s expense, until such time that the site is ready for permanent installation of the equipment.

1.08 MAINTENANCE/SPARE PARTS – (NO SPARE PARTS REQUIRED)

1.09 WARRANTY/EXTENDED WARRANTY

A. The manufacturer shall provide a warranty against loss of performance and defects in materials and workmanship for the Luminaires for a period of five years after acceptance of the
Luminaires. Warranty shall cover all components comprising the luminaire. All warranty documentation shall be provided to customer prior to the first shipment

B. The equipment shall be warranted to be free from defects in workmanship, design, and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no additional cost (including parts, labor, and travel expenses) to the Owner.

C. The manufacturer’s warranty period shall run concurrently with the Contractor’s warranty period. No exception to this provision shall be allowed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Luminaires
1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.
2. Each luminaire shall be designed to operate in the environment in which it is installed.
3. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average operating temperature.

B. LED Sources
1. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours.
2. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
3. Light Color/Quality-
   a. Correlated Color temperature (CCT) range as per specification, between 3500K, 4100K and 5000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
   b. The color rendition index (CRI) shall be 80 or greater.
   c. Color shift over 6,000 hours shall be ≤0.007 change in u’v’ as demonstrated in IES LM80 report.

C. Power Supply and Driver
1. Driver: 120 – 277 volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.
2. When Dimming is specified in the fixture schedule, the driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 5% of rated lumen output with a smooth shut off function. Dimming shall be controlled by a 0-10V signal.
3. Driver shall be UL listed.
4. Maximum stand by power shall be one Watt.
5. Driver disconnect shall be provided where required to comply with codes.
6. The electronics/power supply enclosure shall be internal to the luminaire and be accessible per UL requirements.
7. The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.

D. Electrical

1. Operation Voltage: The luminaire shall operate from a 50 or 60 HZ ±3 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. The standard operating voltages are 120 VAC, 277 VAC, 480 VAC. (See Fixture Schedule for Required Fixure Operating Voltage)

2. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

3. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage.

4. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.

5. RF Interference: The luminaire and associated onboard circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.

6. Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.

E. Photometric Requirements

1. All luminaire must have an IESNA photometric curve produced by a qualified independent lab.

2. Photometric performance of a substitute fixture will be based on the fixture’s calculated illuminance values in the application when compared to the specified fixture. (average, average/min, max/min, lowest point, and highest point)

3. The performance shall be adjusted (depriected) by using the LED manufacturer’s data or the data from the IESNA Standard TM-21 test report, which ever one results in a higher level of lumen depreciation.

F. Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.

2. The LED manufacturer’s maximum junction temperature for the expected life shall not be exceeded at the average operating ambient.

3. The LED manufacturer’s maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.

4. The luminaire shall have an UL IC rating.

5. The Driver manufacturer’s maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
G. Flexible Fixture Hangers
   1. Flexible fixture hangers used in non-hazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be Type EFH as manufactured by the Crouse-Hinds Co., similar by Appleton Electric Co; Killark a Division of Hubbell Inc.
   2. Where required in Section 26 00 00, all pendent-mounted and recessed in suspended ceilings, recessed lighting fixtures shall be provided with four anti-sway supports to meet Type I seismic requirements.

H. Fixtures
   1. Refer to Drawing for fixture ID and model number.

I. Lighting Pole
   1. Refer to Drawing for fixture ID and model number.

J. Lighting Controller
   1. Refer to Drawing for controller ID and model number.

2.02 CONTROLS (NOT USED)
2.03 FACTORY TESTS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION / PREPARATION (NOT USED)

3.02 INSTALLATION
   A. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.
   B. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.
   C. Fixtures noted to be installed flush in suspended ceilings shall be of mounting types suited for the type ceiling involved. It shall be the responsibility of the electrical contractor to verify the ceiling types prior to ordering fixtures.
   D. Fixture to be recessed mounted in suspended lay-in grid ceiling, dry wall or other ceiling type up to 1½ inch thick. Contractor to verify exact ceiling type prior to ordering luminaires to insure compatibility with ceiling thickness. Provide ceiling adaptor as required to accommodate ceiling thickness up to 2 inches. Bottom of luminaire shall be flush with ceiling.
   E. Flexible fixture hangers shall be used for all pendant mounted fixtures. Fixtures two feet long and larger shall be supported with a minimum of two fixture hangers.
   F. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.
   G. Exterior lighting poles shall be mounted plumb.
   H. Fixture locations are shown on the Drawings in approximate locations; however exact locations shall be coordinated so as to avoid conflicts with HVAC ducts, equipment, and other obstacles.
I. Where the Drawings state a particular mounting height, it shall imply that the bottom of the fixture shall be mounted at the stated mounting height above the finished floor, unless specifically noted otherwise.

J. The minimum mounting height for the bottom of lights and exit signs shall be 80 inches above the finished floor in compliance with Americans with Disabilities Act (ADA).

K. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 501.

L. Flangeless fixtures for recess mounting in drywall shall be provided with mud ring and plaster guard, install per manufacturer’s instructions.

M. Install all required hardware and mounting brackets to secure luminaires to structure per local code requirements.

N. Bond luminaires and metal accessories to branch circuit equipment grounding conductor.

3.03 INSPECTION (NOT USED)

3.04 FIELD TESTING

A. Perform field inspection, testing, and adjusting in accordance with manufacturer’s recommendations.

B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

C. Test and calibrate all controls associated with luminaires, i.e. integral photo cells and occupancy sensors.

3.05 FIELD PAINTING (NOT USED)

3.06 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from lens enclosures
   1. For cleaning acrylic lenses or diffusers, use a feather duster or dry cotton cheesecloth to rid the lens/diffuser of any minor dust. For fingerprints, smudges, or other dirt present, use an ammonia-based cleaner (such as Windex) and wipe carefully with cotton cheesecloth (so as to avoid injury from any prismatic texture of the lens).
   2. Job site contamination may not necessarily be removed using the above recommendations. In that case the lens would need to be replaced.

C. Clean photometric control surfaces as recommended by manufacturer.

D. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

END OF SECTION
SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
1. Preparing subgrades for roadways, structures, slabs-on-grade, and related facility work not specified elsewhere.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subsurface drainage backfill for walls and trenches.

B. Related Sections:
1. Division 31 Section 31 11 00 "Site Clearing & Grubbing" for temporary erosion and sedimentation control measures, site clearing, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section 31 23 19 "Dewatering" for dewatering system for excavations
3. Division 31 Section 31 23 33 "Excavation, Trenching, and Backfilling" for excavation, trenching and backfilling for utilities.
4. Division 31 Section 31 50 00 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.

1.03 REFERENCES

A. Definitions.
1. Backfill: Soil material or controlled low-strength material used to fill an excavation.
2. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
3. Completed Course: A course or layer that is ready for next layer or next phase of Work.
4. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
5. Earthwork: Includes excavation, fill and compaction, grading, and disposal of waste and surplus material.
6. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   a. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
   b. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
c. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

7. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, stripping of topsoil, excavation or fill to grade, and subgrade preparation.

8. Fill: Soil materials used to raise existing grades.

9. Lift: Loose (uncompacted) layer of material.

10. Optimum Moisture Content: Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

11. Relative Compaction: Ratio, in percent, of as-compact field dry density to laboratory maximum dry density as determined in accordance with ASTM D698. Apply corrections for oversize material to either as-compact field dry density or maximum dry density, as determined by ENGINEER.

12. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
   a. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.
   b. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 48,510-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

13. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

14. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

15. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

16. Well-Graded: A mixture of particle sizes that has no specific concentrations or lack thereof of one or more sizes producing a material type which, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

17. Reference Standards.
   a. ASTM International:
      i) D448 — Standard Method Classification for sizes of Aggregate for Road and Bridge construction.
      ii) D698 — Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,499 ft-lb.ft3 (600 kN-m/m3))
      iii) D2487 — Standard Method Classification of Soils for Engineering Purposes (Unified Soil Classification system)
iv) D2922 — Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

   M288 — Geotextile Specification for Highway Application

c. Texas Department of Transportation: Standard Specifications for Construction of Highways, Streets and Bridges. (TxDOT).

   i) TxDOT Item 216 "Proof Rolling"

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Geotextile, if specified on Drawings.
   2. Controlled low-strength material, including design mixture.

B. Samples: 12-by-12-inch Sample of subdrainage and/or separation geotextile.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.
   3. Designated submittals for materials per Division 1.

D. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, which might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.05 PROJECT CONDITIONS

A. Existing Utilities: If applicable, do not interrupt utilities serving facilities occupied by OWNER or others unless permitted in writing by ENGINEER and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify ENGINEER not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without ENGINEER’S written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities as indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Weather Limitations:
   1. Material excavated when frozen or when air temperature is less than 32°F shall not be used as fill or backfill until material completely thaws.
   2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.
PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Satisfactory soils shall comply with the requirements of (Division 31 Section 31 05 13 "Soils for Earthwork").

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
   2. Depending on the plasticity index (PI) and liquid limits (LL) Soil Classification Groups GC and SC may be used.

2.02 DRAINAGE COURSE AND FILTER MATERIAL

A. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

B. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

2.03 GEOTEXTILES

A. Subsurface Drainage Geotextile: When shown on Drawings, provide non-woven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefin or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2; AASHTO M 288.
   2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
   3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
   4. Tear Strength: 56 lbf; ASTM D 4533.
   5. Puncture Strength: 56 lbf; ASTM D 4833.
   6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
   7. Permittivity: 0.2 per second, minimum; ASTM D 4491.
   8. UV Stability: 50 percent after 500 hours’ exposure; ASTM D 4355.

B. Separation Geotextile: If shown on the Drawings, provide woven geotextile fabric, manufactured for separation applications, made from polyolefin or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2; AASHTO M 288.
   2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lb; ASTM D 4632.
4. Tear Strength: 90 lb; ASTM D 4533.
5. Puncture Strength: 90 lb; ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.04 MATERIAL QUALITY CONTROL

A. Sampling of material stockpiles and material sources shall be in accordance with ASTM D75.
B. Perform gradation analysis in accordance with ASTM C136 for: Coarse and fine aggregate, natural gravel, crushed stone for foundation, sand, select fill, impervious clay fill, earth fill, and topsoil.
C. Perform abrasion testing in accordance with ASTM C131 or ASTM C535. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
D. Soundness testing in accordance with ASTM C88. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
E. Deleterious materials determination in accordance with ASTM C40, C117, and C142. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
F. Determine liquid limit and plasticity index in accordance with ASTM D4318. 1. Sand for particles passing No. 8 sieve, select fill, impervious clay fill, and earth fill.
G. Determine pH of topsoil in accordance with ASTM D2974.
H. Determine permeability (hydraulic gradient) in accordance with ASTM D5084 and percent dispersion in accordance with ASTM D4221 of impervious clay fill materials.
I. Provide tests results showing flowable fill mix design achieves desired compressive strength.

2.05 CONTAMINATION TESTING AND CERTIFICATION

A. When materials are suspected of contamination, the CONTRACTOR shall arrange and pay for the services of an EPA approved laboratory to perform a toxic contaminant scan of composite borrow material samples in accordance with Division 1.
B. Soil materials derived from the excavation of underground petroleum storage tanks shall not be used as fill on Project.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section 31 11 00 "Site Clearing and Grubbing."
C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section 31 11 00 “Site Clearing and Grubbing,” during earthwork operations.

D. Provide excavation support and protection in accordance with Division 31 Section 31 50 00 “Excavation Support and Protection”.

E. Excavation, trenching, and backfilling work for utilities shall be accomplished in accordance with Division 31 Section 31 23 33 “Excavation, Trenching, and Backfilling for Utilities.”

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. Install a dewatering system, specified in Division 31 Section 31 23 19 “Dewatering” to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.03 EXPLOSIVES

A. Explosives: Comply with the requirements of Division 31 Section 31 11 00 “Site Clearing and Grubbing”

3.04 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials. Division 31 Section 31 11 00 “Site Clearing and Grubbing”.
   2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 12 inches outside of concrete forms at footings.
      c. 6 inches outside of minimum required dimensions of concrete cast against grade.
      d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      e. 6 inches beneath bottom of concrete slabs on grade.

3.05 EXCAVATION FOR STRUCTURES

A. Excavate to specified elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to
required lines and grades to leave solid base to receive other work. Refer to Drawings for treatment of subgrade, the addition of a concrete seal slab, installation of vapor barrier, or other work required prior to placement of footings and foundations.

2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.

3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Undercutting:
   1. When objectionable material not suitable for foundation or subgrade material is present in locations for subgrade or foundation construction, as determined by ENGINEER, undercut material to the depth and extent as directed and backfill with suitable material.
   2. Place fill material in uniform layers and compact as specified for soil backfill and fills.
   3. Dispose of undercut materials off-site.

3.06 SUBGRADE INSPECTION
   A. Notify ENGINEER when excavations have reached required subgrade.
   B. If ENGINEER determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
   C. Proof roll subgrade to identify soft pockets and areas of excess yielding using rollers that when loaded weigh at least 25 tons and no more than 50 tons.
      1. Do not proof-roll wet or saturated subgrades.
      2. Make at least two passes, offsetting each pass one tire width. Operate at speed between 2 and 6 miles per hour.
      3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by ENGINEER, and replace with compacted backfill or fill as directed.
   D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
   E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by ENGINEER, without additional compensation.

3.07 UNAUTHORIZED EXCAVATION
   A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by ENGINEER. Fill unauthorized excavations under other construction or utility pipe as directed by ENGINEER.

3.08 STORAGE OF SOIL MATERIALS
   A. Stockpile borrows soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
      1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
2. Confine stockpiles to within easements, right-of-way, and approved areas. Do not obstruct roads or streets.

3.09 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following work as applicable:
   1. Construction below finish grade including, where applicable, subdrainage, damp proofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
   8. Leakage tests for structures.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use select or granular fill unless otherwise shown on Drawings.
   3. Under steps and ramps, use select or granular fill, unless otherwise shown on Drawings.
   4. Under building slabs, use select or granular fill, unless otherwise shown on Drawings.

C. Place soil fills on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content, if not specified on the Drawings or in the Geotechnical Report.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
   3. Refer to notes on the structural plans for moisture requirements at the new water treatment plant building area.
3.12 COMPACTION OF SOIL BACKFILLS AND FILLS
   A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
   B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
   C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698, if not specified on the Drawings:
      1. Under structures, building slabs, steps, and pavements, scarify and compact top 12 inches of existing subgrade and each layer of backfill or fill soil material against underground structural walls at 95 percent.
      2. Under walkways, scarify and compact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
      3. Under lawn or unpaved areas, scarify and compact top below subgrade and compact each layer of backfill or fill soil material at 90 percent.

3.13 GRADING
   A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
      1. Provide a smooth transition between adjacent existing grades and new grades.
      2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
   B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
      1. Lawn or Unpaved Areas: Plus or minus 1-inch.
      2. Walks: Plus or minus 1 inch.
      3. Pavements: Plus or minus 1/2 inch.
   C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 SUBSURFACE DRAINAGE
   A. When shown on the Drawings, provide subsurface drainage in accordance with the following paragraphs.
   B. Subdrainage Pipe: As specified in Division 31 Section 31 23 19 "Dewatering"
   C. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6 inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
   D. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage...
backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
2. As shown on the Drawings, place and compact impervious fill over drainage backfill in 6 inch thick compacted layers to final subgrade.

3.15 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   2. Place drainage course 6-inches or less in compacted thickness in a single layer.
   3. Place drainage course that exceeds 6-inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6-inches thick or less than 3 inches thick.
   4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 CONCRETE SEAL SLAB

A. When shown on the Drawings, provide a concrete seal slab on subgrade under structures of the specified thickness. Concrete shall comply with Division 3 Section 03 30 00 "Cast-In-Place Concrete" having a compressive strength of 3,000 psi.

3.17 FIELD QUALITY CONTROL

A. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

B. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by ENGINEER.

C. Testing agency will test compaction of soils in place according to ASTM D 2922. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.
3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specify tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by ENGINEER; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing. 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and stockpile on-site of OWNER’S property. Surplus soil if free of debris and trash may be disposed of on the OWNER’S property when approved by the OWNER.

END OF SECTION
SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1  GENERAL

1.01  RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.02  SUMMARY
A. This Section provides the requirements for materials used for preparation of roadway fill, subgrade and base; structural subgrade and backfill; utility subgrade, bedding, embedment, and backfill; embankment and levee subgrade and fill; and other materials for related work.

1.03  SUBMITTALS
A. Submittals for Review.
1. Samples: As required by ENGINEER, provide one-gallon sample in a sealed container.
2. Contractor Design Mix Determination: Submit proposed mix design for Controlled Low Strength Material and preliminary results demonstrating the mix design achieves required compressive strength.

B. Submittals for Information.
1. Source of Materials: Submit name and location of source of materials.
2. Off-Site Borrow Source: Prior to furnishing off-site borrow (soils), provide notarized certification from the landowner stating to the best of landowner's knowledge and belief, the borrow source has never been contaminated by hazardous and/or toxic waste materials.
3. Certified Analysis: Submit test results by independent laboratory of material compliance with specifications. Results shall not be more than 30 days old.

1.04  REFERENCES
A. Definitions.
1. Well-Graded: A mixture of particle sizes that has no specific concentrations or lack thereof of one or more sizes producing a material type which, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

B. Reference Standards: Following are standards that may be referenced in this Section.
1. American Concrete Institute, ACI 229. — Controlled Low Strength Materials.
2. ASTM International (ASTM):
   c. C88 — Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.


l. D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

m. D1140 — Standard Test Method for Amount of Materials in Soils Finer than the No. 200 (75 micrometer) Sieve.

n. D2487 — Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).


3. Texas Department of Transportation, Standard Specifications for Construction of Highways, Streets, and Bridges (TxDOT).

a. TxDOT Item 247 "Flexible Base"

4. Texas Department of Transportation, Manual of Testing Procedures (TEX):

a. TEX-110-E "Particle Size Analysis of Soils"

b. TEX-116-E "Ball Mill Method for Determining the Disintegration of Flexible Base Material"

c. TEX-117-E "Triaxial Compression for Disturbed Soils and Base Materials"

d. TEX-411-A "Soundness of Aggregate Using the Los Angeles Machine"

e. TEX-460-A "Determining Crushed Face Particle Count"

1.05 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection.
1. Stockpile excavated materials and imported materials in designated areas or in areas approved by ENGINEER. Clearly identify stockpiles.

2. Lightly compact top and slope stockpiles to prevent excessive erosion and ponding of water.

3. Store and handle materials in a manner to prevent contamination.

B. Erosion and Sedimentation Control: Provide silt fences and surface drainage control at material stockpile areas in accordance with the Storm Water Pollution Prevention Plan (SWPPP).

PART 2 PRODUCTS

2.01 GENERAL

A. Various site preparation, earthwork, trenching, and roadway subgrade and base sections reference the materials listed in the following paragraphs. Not all materials listed in this Section are used on the Project.

B. Sampling of materials shall be in accordance with ASTM D75.

2.02 GRANULAR MATERIAL

A. Granular material shall be free flowing, such as sand or hydraulically graded crushed stone fines, or mixed sand and gravel. The material shall be free from lumps, stones over 2-inches in diameter, clay and organic matter. The granular material shall be classified as GW, GP, GM, GC, SW, or SP according to Unified Soil Classification System, ASTM D2487.

2.03 COARSE AGGREGATE

A. Coarse aggregate shall consist of gravel, crushed gravel, and crushed stone. It shall consist of sound and durable particles, free from frozen materials or injurious amounts of salts, alkali, organic matter of other material either free or as adherent coating, and reasonably well graded between the prescribed limits listed in Table 1 when tested in accordance with ASTM C136.

B. Abrasion: It shall have a wear of not more than 40 percent when tested in accordance with ASTM C131 or ASTM C535.

C. Soundness: When material is subjected to five (5) cycles of the sodium sulfate soundness test in accordance with ASTM C88, the weighted percentage of loss shall not exceed 12 percent.

D. Amount of material finer than 75-micrometer (No. 200) sieve: Coarse aggregate for embedment shall contain no more than one percent by weight organic matter (other than native bitumen), clays, loam or pebbles coated therewith, and shall contain no more than five percent by weight on any one or combination of slate, schist or soft particles of sandstone.

E. Each class of aggregate gradation shall comply with the applicable gradation limits listed in Table No. 1, when tested in accordance with ASTM C136.
Table No. 1
Coarse Aggregate Gradation

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Aggregate Size No. 467 (1-1/2 to No. 4)</th>
<th>Aggregate Size No. 4 (1-1/2 to 3/4 in.)</th>
<th>Aggregate Size No. 57 (1 in. to No. 4)</th>
<th>Aggregate Size No. 67 (3/4 in. to No. 4)</th>
<th>Aggregate Size No. 8 (3/8 in. to No. 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in.</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-1/2 in.</td>
<td>95 to 100</td>
<td>90 to 100</td>
<td>95 to 100</td>
<td>90 to 100</td>
<td></td>
</tr>
<tr>
<td>1 in.</td>
<td>----</td>
<td>20 to 55</td>
<td>95 to 100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3/4 in.</td>
<td>35 to 70</td>
<td>0 to 5</td>
<td>0 to 5</td>
<td>90 to 100</td>
<td>100</td>
</tr>
<tr>
<td>1/2 in.</td>
<td>----</td>
<td>25 to 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8 in.</td>
<td>10 to 30</td>
<td>0 to 5</td>
<td>0 to 5</td>
<td>20 to 55</td>
<td>85 to 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 to 5</td>
<td>0 to 10</td>
<td>0 to 10</td>
<td>10 to 30</td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td>----</td>
<td>0 to 5</td>
<td>0 to 5</td>
<td>0 to 10</td>
<td></td>
</tr>
<tr>
<td>No. 16</td>
<td>----</td>
<td>0 to 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Amounts Finer than Each Laboratory Sieve Mass Percent

Aggregate Size Number and gradation is in accordance with ASTM C33 and ASTM D448.

PART 3 EXECUTION

3.01 FINE aggregate

A. Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof, complying with the requirements for abrasion, soundness, and impurities as specified for coarse aggregate.

B. The fine aggregate gradation shall comply with the applicable gradation limits, when tested in accordance with ASTM C136. Fine aggregate shall not have more than 45% passing any sieve and retained on the next consecutive sieve shown in Table No. 2 and, its fineness modulus shall not be less than 2.3 or more than 3.1.

Table No. 2
Fine Aggregate Gradation

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 in.</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95 to 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>80 to 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>50 to 85</td>
</tr>
<tr>
<td>No. 30</td>
<td>25 to 60</td>
</tr>
<tr>
<td>No. 50</td>
<td>5 to 30</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 to 10</td>
</tr>
</tbody>
</table>

Gradation in accordance with ASTM C33
Fine Aggregate.

C. Plasticity index shall be less than 6 for material passing No. 30 sieve.

3.02 NATURAL GRAVEL

A. Natural gravel shall consist of uncrushed stones, washed and screened, complying with the requirements for abrasion, soundness, and impurities as specified for coarse aggregate.
B. The aggregate gradation shall comply with the gradation limits listed in Table No. 3, when tested in accordance with ASTM C136.

<table>
<thead>
<tr>
<th>Table No. 3</th>
<th>Natural Gravel Gradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing or Retained on Sieve</td>
<td>Percent by Weight</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td></td>
</tr>
<tr>
<td>Passing on 1-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>Retained on 3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td></td>
</tr>
<tr>
<td>Passing on 3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>Retained on No. 4</td>
<td>100</td>
</tr>
</tbody>
</table>

3.03 CRUSHED STONE FOR FOUNDATION

A. Crushed stone for foundations shall comply with the requirements for abrasion, soundness, and impurities as specified for coarse aggregate.

B. Unless otherwise shown on the drawings, the aggregate gradation shall comply with the gradation limits listed in Table No. 1: Aggregate Size No. 57 or No. 67, when tested in accordance with ASTM C136.SAND

C. Sand shall consist of well-graded, clean, hard, durable, uncoated grains, free from lumps and organic material having a Soil Classification SW. Sand particles will pass a No. 4 sieve and be retained on a No. 200 sieve with the subdivisions as listed in Table No.4. If gradation subdivision not indicted, provide sand complying with the above.

<table>
<thead>
<tr>
<th>Table No. 4</th>
<th>Sand Gradation Subdivisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing or Retained on Sieve</td>
<td>Percent by Weight</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td></td>
</tr>
<tr>
<td>Passing No. 4</td>
<td>100</td>
</tr>
<tr>
<td>Retained on No. 10</td>
<td>100</td>
</tr>
<tr>
<td>Medium Sand</td>
<td></td>
</tr>
<tr>
<td>Passing on No. 10</td>
<td>100</td>
</tr>
<tr>
<td>Retained on No. 40</td>
<td>100</td>
</tr>
<tr>
<td>Fine Sand</td>
<td></td>
</tr>
<tr>
<td>Passing on No. 40</td>
<td>100</td>
</tr>
<tr>
<td>Retained on No. 200</td>
<td>100</td>
</tr>
</tbody>
</table>

Gradation requirements obtained from ASTM D2487.

3.04 PEA GRAVEL

A. Pea Gravel: Conforming to ASTM C33, Aggregate Size No. 8, and coarse aggregate graded with 100 percent passing a 3/8-inch sieve and 90 percent retained on a No. 4 sieve.

3.05 CONCRETE ENCASEMENT

A. Provide Ready mixed concrete prepared in accordance with ASTM C94. Select and proportion ingredients to obtain a minimum compressive strength of 2,000 psi at 28 days.
B. Materials:
   1. Cement: ASTM C150, Type I or Type II.
   2. Aggregate: ASTM C33, Size 67 or similar.
   3. Fly Ash (if used): ASTM C618, Class C.
   4. Water: Clean, potable, free of odor, organics, and deleterious materials.

C. Slump: Not less than 1-inch, cushion portion of embedment; 1 to 3 inches for the sides and top of encasement.

3.06 CONTROLLED LOW STRENGTH MATERIAL (FLOWABLE FILL)

A. Ready mixed flowable fill is a blend of cement, fly ash, fine aggregate, and water. It is designed as a low strength, flowable material requiring no subsequent vibration or tamping to achieve 100% consolidation.

B. Unless indicated otherwise, select and proportion ingredients to obtain compressive strength between 50 and 150 psi at 28 days in accordance with ASTM D4832.

C. Materials:
   1. Cement: ASTM C150, Type I, II, or III.
   2. Aggregate: ASTM C33, Size 8 or fine aggregate.
   3. Fly Ash (if used): ASTM C618, Class C.
   4. Water: Clean, potable, free of odor, organics, and deleterious materials.

D. The flowable fill mixture shall be mixed either in a pug mill, concrete mixer, or transit mixer and shall have a minimum slump of 5-inches.

3.07 CEMENT-SOIL BACKFILL

A. Mixture of Portland cement and sand complying with the requirements of Division 2.

3.08 FLEXIBLE BASE

A. Material Type: Unless otherwise specified, provide either crushed stone or crushed gravel as described below:
   1. Crushed Stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Do not use gravel or multiple sources.
   2. Crushed Gravel with a minimum of 60% of the particles retained on a No. 4 sieve with two or more crushed faces as determined by TEX-460-A, Part I. Blending of two or more sources is allowed.

B. Material Grade: Unless other specified on the Drawings, aggregate used as flexible base material, shall comply with the requirements listed in Table 5, Grade 2. Do not use additives such as, but not limited to lime, cement, or fly ash to modify aggregate to meet requirements of Table 5, unless shown on the Drawings.
<table>
<thead>
<tr>
<th>Property</th>
<th>Method</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Gradation</td>
<td>Tex-110-E</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sieve Size (% Retained)</td>
<td></td>
<td>0 - 10</td>
<td>0 - 10</td>
<td></td>
</tr>
<tr>
<td>2-1/2 inch</td>
<td></td>
<td>10 - 35</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1-3/4 inch</td>
<td></td>
<td>30 - 50</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7/8-inch</td>
<td></td>
<td>45 - 65</td>
<td>45 - 75</td>
<td>45 - 75</td>
</tr>
<tr>
<td>3/8-inch</td>
<td></td>
<td>70 - 85</td>
<td>60 - 85</td>
<td>50 - 85</td>
</tr>
<tr>
<td>No. 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid Limit % Max.</td>
<td>ASTM</td>
<td>35</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Plasticity Index °A Max.</td>
<td>D4318</td>
<td>10</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Wet Ball Mill Maximum</td>
<td></td>
<td>40</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Wet Ball Mill, %/0 Max. increase passing No. 40</td>
<td>Tex-116-E</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Classification 2</td>
<td></td>
<td>1.0</td>
<td>1.1 to 2.3</td>
<td></td>
</tr>
<tr>
<td>Minimum Compressive Strength, psi at:</td>
<td>Tes-117-E</td>
<td></td>
<td></td>
<td>---</td>
</tr>
<tr>
<td>Lateral Pressure 0 psi</td>
<td></td>
<td>45</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Lateral Pressure 15 psi</td>
<td></td>
<td>175</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td>Foreign Material, °A Max.</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

1. When soundness value required by Drawings, test material in accordance with Tex-411-A.
2. Meet both the classification and the minimum compressive strength, unless otherwise shown on the Drawings.
3. For work under TxDOT jurisdiction the flexible base material shall comply with the requirements of TxDOT Item 247, "Flexible Base", Type A, Grade 2, or Type C, Grade 2, unless otherwise indicted on the Drawings.

3.09 SELECT FILL

A. Select fill shall consist of non-expansive material, such as gravel, fine stone cuttings, sand, sandy loam, or loam free from excessive clay, roots, grass, trash, or other organic materials. Stone cuttings shall have no dimension greater than 2-inches. Use approved material excavated from site or imported material.

B. Select fill shall have a liquid limit of 35 or less; plasticity index between 5 and 17; and gradation approximately the limits indicated in Table No. 6.
Table No. 6
Select Fill

<table>
<thead>
<tr>
<th>Retained on Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>25 to 50</td>
</tr>
<tr>
<td>No. 40</td>
<td>50 to 85</td>
</tr>
<tr>
<td>No. 200</td>
<td>Not less than 35% fines passing</td>
</tr>
<tr>
<td></td>
<td>Maximum aggregate size: 1-3/4 inches</td>
</tr>
</tbody>
</table>

3.10 IMPERVIOUS CLAY FILL

A. Impervious clay fill shall be placed as indicated on the Drawings. The material shall not be used as backfill against walls of structures except in the upper two feet.

B. The material shall consist of soil materials classified as CH or CL in accordance with ASTM D2487; have a minimum liquid limit of 40; have a minimum plasticity index of 20; have a minimum of 50 percent by weight passing a No. 200 sieve; and shall be free of organics or other deleterious materials.

C. The material shall have a percent dispersion of less than 20 when tested in accordance with ASTM D4221. The material, when compacted to the recommended moisture and density, shall have permeability less than 1x10^-6 cm/s (1 ft/yr), as determined by remolded specimens of the actual materials proposed, in accordance with ASTM D5084.

3.11 SITE FILL

A. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3-inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

B. Material shall have a liquid limit of 40 or less; plasticity index between 4 and 20; and gradation approximately the limits indicated in Table No. 7.

Table No. 7
Site Fill

<table>
<thead>
<tr>
<th>Retained on Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>Less than 35</td>
</tr>
<tr>
<td>No. 200</td>
<td>Less than 65</td>
</tr>
</tbody>
</table>

3.12 TOP SOIL

A. Material shall be natural friable loam; free of subsoil, roots, grasses, and excessive amount of weeds, stone, and foreign matter.

B. Material shall have a acidity range (pH) between 5.5 to 7.5; an organic matter content between 4 to 25 percent in accordance with ASTM D2974; and a gradation complying with Table No. 8.

Table No. 8
Top Soil

<table>
<thead>
<tr>
<th>Retained on Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>Less than 35</td>
</tr>
<tr>
<td>No. 200</td>
<td>Less than 65</td>
</tr>
</tbody>
</table>
3.13 UNCLASSIFIED EXCAVATION
   A. All material excavated from site not meeting the requirements for materials specified above.

3.14 MATERIAL QUALITY CONTROL
   A. Sampling of material stockpiles and material sources shall be in accordance with ASTM D75.
   B. Perform gradation analysis in accordance with ASTM C136 for:
      1. Coarse and fine aggregate, natural gravel, crushed stone for foundation, sand, select fill, impervious clay fill, earth fill, and topsoil.
   C. Perform abrasion testing in accordance with ASTM C131 or ASTM C535.
      1. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
   D. Soundness testing in accordance with ASTM C88.
      1. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation.
   E. Deleterious materials determination in accordance with ASTM C40, C117, and C142. 1. Coarse and fine aggregate and when requested by ENGINEER for natural gravel and crushed stone for foundation
   F. Determine liquid limit and plasticity index in accordance with ASTM D4318. 1. Sand for particles passing No. 8 sieve, select fill, impervious clay fill, and earth fill.
   G. Determine pH of topsoil in accordance with ASTM D2974.
   H. Determine permeability (hydraulic gradient) in accordance with ASTM D5084 and percent dispersion in accordance with ASTM D4221 of impervious clay fill materials.
   I. Provide tests results showing flowable fill mix design achieves desired compressive strength.

END OF SECTION
SECTION 311100
SITE CLEARING AND GRUBBING

PART I GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.02 SUMMARY
   A. This Section specifies site clearing activities including trees and vegetation removal and root grubbing, tree protection, topsoil stripping and stockpiling, capping and removing utilities, temporary erosion and sedimentation control measures, and removing minor above- and below-grade site improvements.
   B. This section does not include detailed tree protection and trimming, tree and root pruning, or tree relocation; grading, excavating, backfilling for earthwork and trenching; building and selective demolition; or landscaping.
   C. Related Sections include the following:
      1. Section 310000 "Earthwork" and Section 312333 “Excavation, Trenching and Backfilling” for soil materials, excavating, backfilling, and site grading.

1.03 DEFINITIONS
   A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying.
   B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
   C. Grubbing: Removal of vegetation and other organic matter, including stumps, buried logs, and roots greater than two-inch caliber to a depth as specified in the following paragraphs.
   D. Scalping: Removal of sod without removing more than upper 3-inches of topsoil.
   E. Stripping: Removal of topsoil remaining after applicable scalping is completed.
   F. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter, and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.
   G. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.
   H. Project Limits: Areas, as shown or specified, within which work is to be performed.
1.04 MATERIAL OWNERSHIP
   A. Except for stripped topsoil or other materials indicated to remain OWNER'S property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.05 SUBMITTALS
   A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
   B. Record drawings identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.06 QUALITY ASSURANCE
   A. Preconstruction Conference: Conduct preinstallation conference at Project site to comply with requirements in the General and Supplementary Conditions of the Contract.

1.07 PROJECT CONDITIONS
   A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
      1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from OWNER and authorities having jurisdiction.
      2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
   B. Salvageable Improvements: As applicable, carefully remove items indicated to be salvaged and store on OWNER'S premises where indicated.
   C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
   D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 PRODUCTS

2.01 SOIL MATERIALS
   A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 00 00 "Earthwork."
      1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 EXECUTION

3.01 PREPARATION
   A. Protect and maintain benchmarks and survey control points from disturbance during construction.
   B. Locate and clearly flag trees and vegetation to remain or to be relocated.
C. Protect existing site improvements to remain from damage during construction. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Storm Water Pollution Prevention Plan (SWPPP):
   1. CONTRACTOR shall obtain a permit to discharge storm water from the construction site from Texas Commission on Environmental Quality (TCEQ) in accordance with TPDES General Permit No. TXR150000 (Permit).
   2. The CONTRACTOR shall comply with all requirements of the Permit, including the development of a SW3P, filling of the Notice of Intent (NOI) and Notice of Termination (NOT), record maintenance, and posting of the Permit.
   3. Costs associated with obtaining and compliance with the Permit are the CONTRACTOR’S responsibility.
   4. Submit a copy of the SW3P application and other pertinent TCEQ submittals to the ENGINEER and the OWNER two weeks prior to submitting to TCEQ.

B. Temporary Erosion and Sedimentation Control:
   1. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff to adjacent properties and walkways, according to a sediment and erosion control plan, specific to the site, which complies with the requirements of TCEQ, or EPA 832/R-92-005, or requirements of authorities having jurisdiction, whichever is more stringent.
   2. The CONTRACTOR shall have the sole responsibility for the means, methods, techniques, sequences, and procedures for furnishing, installing and maintaining the erosion and sedimentation control system.
   3. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
   4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 TREE PROTECTION (NOT USED)

3.04 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed. Arrange with utility companies to shut off indicated utilities.

B. Comply with requirements related to existing utilities and utility shutdowns as indicated in the Uniform General Conditions, General and Supplementary Conditions of the Contract.

C. Excavate for and remove underground utilities as indicated to be removed.

3.05 LIMITS OF CLEARING

A. As follows, but not to extend beyond Project limits shown on the Drawings.
   1. Excavation, Excluding Trenches: 5 feet beyond top of cut slopes.
   2. Trench Excavation: 4 feet from trench centerline, regardless of trench width.
   3. Fill:
      a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
b. Stripping: 2 feet beyond toe of permanent fill.
4. Roadways: Clearing and grubbing 20 feet from roadway centerline.
6. Other Areas: As shown on drawings.

B. Remove rubbish, trash and junk from entire area within Project limits.

3.06 BLASTING
A. No blasting will be allowed on this project.

3.07 BURNING
A. No burning allowed on this project.

3.08 CLEARING AND GRUBBING
A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
   4. Use only hand methods for grubbing within tree protection zone.
   5. Chip removed tree branches and dispose of off-site unless directed by Engineer to use for Erosion control.

B. As required, fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.09 TOPSOIL STRIPPING
A. Remove sod and grass before stripping topsoil.
B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Limit height of topsoil stockpiles to approximately 6 feet.
   2. Do not stockpile topsoil within tree protection zones.
   3. Dispose of excess topsoil as specified for waste material disposal.

3.10 SITE DEMOLITION
A. Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Neatly saw-cut length of existing pavement to remain at the line of demolition before removing existing pavement. Saw-cut faces vertically.
   2. Epoxy coat cut ends of steel reinforcement in concrete to remain to prevent corrosion.

C. Demolition of large structures and facilities shall comply with the requirements of Section 02 41 13 "Selective Site Demolition".

3.11 DISPOSAL

A. Disposal:
   1. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off OWNER'S property.
   2. Dispose of stockpiled waste materials within 30-days.
   3. When requested by OWNER, provide copies of the landfill receipts for waste material disposal.

END OF SECTION
SECTION 31 23 19

DEWATERING

PART 1  GENERAL

1.01  RELATED DOCUMENTS

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

1.02  SUMMARY

A.  Section includes construction dewatering.

B.  Related Sections:
   1.  Division 31 Section 31 00 00 "Earthwork" for excavating, backfilling, site grading, and for site utilities.
   2.  Division 31 Section 31 23 33 "Excavation, Trenching, and Backfilling" for excavation, trenching and backfilling for utilities.
   3.  Division 31 Section 31 50 00 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.

1.03  PERFORMANCE REQUIREMENTS

A.  Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
   1.  Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer license to practice in the state where the Project is to be constructed, using performance requirements and design criteria indicated.
   2.  Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
   3.  Prevent surface water from entering excavations by grading, dikes, or other means.
   4.  Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
   5.  Remove dewatering system when no longer required for construction.

1.04  SUBMITTALS

A.  Action Submittal. Provide shop drawings for dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

B.  Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C.  Informational submittals
1. Qualification Data: For qualified Installer, land surveyor and professional engineer as applicable.

2. Field quality-control reports.

3. Other Informational Submittals:
   a. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations, if applicable.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

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

1.06 PROJECT CONDITIONS

A. Interruption of Existing Utilities: As applicable, do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
   1. Notify Engineer no fewer than twenty-one (21) days in advance of proposed interruption of utility.
   2. Do not proceed with interruption of utility without ENGINEER's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
   1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
   2. The geotechnical report is referenced elsewhere in the Project Manual.

C. Survey Work: If applicable, engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 31 Section 31 11 00 Site Clearing and Grubbing during dewatering operations.

3.02 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.

2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Unless otherwise specified in the Geotechnical Report, maintain piezometric water level a minimum of 24 inches below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.03 FIELD QUALITY CONTROL

A. Observation Wells: When shown on Drawings, provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.

3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

END OF SECTION
SECTION 31 23 33
EXCAVATION, TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work under this Section of the Specifications consists of furnishing all labor, equipment and materials, and performing all operations in connection with the excavation, trenching, backfill, embedment and concrete encasement required to install the pipelines shown on the Drawings, and as specified.

B. Excavation shall include the removal of any trees, stumps, brush, debris, or other obstacles that may obstruct the line of work, and the excavation, and removal of all earth, rock or other materials to the extent necessary to install the pipe and appurtenances in conformance with the lines and grades shown on the Drawings, or as specified.

C. Backfill shall include the refilling and consolidation of the fill in the trenches and excavations up to the surrounding ground surface or road grade at crossing. The backfill from the trench bottom to 12-inches above the top of the pipes and conduit when laid to the grade including the bedding layer sustaining the pipeline as shown on the drawings is termed “embedment”. Backfill above the embedment is termed “final backfill”.

D. Where construction enters the limits of City, State or County rights-of-way, the requirements of these agencies shall be met.

1.02 RELATED WORK

A. Special Conditions

B. Section 03 30 00 - Cast-in-Place Concrete.

C. Section 31 11 00 - Site Clearing and Grubbing

D. Section 31 23 19 - Dewatering

E. Section 31 41 33 - Trench and Excavation Safety Systems

1.03 SUBMITTALS

A. Submit the following:

1. Certified test reports for embedment material, aggregates, and select material. Certified Test Reports shall be from an independent laboratory paid for by the Contractor. Test reports shall include sieve analysis, soil classification, percentage of wear, Atterberg limits, and soil resistivity tests for embedment material.

2. Record data showing station and elevation of existing utilities based upon Contractor's field investigation as required by the Contract Documents.

3. Mix design data for flowable fill, including 3-day and 28-day unconfined compressive strength.

4. Provide a submittal showing the proposed methods to support the pipe and prevent flotation during flowable fill placement. The submittal shall include a description of the system and methods that the Contractor proposes to mitigate the potential for and monitor pipe floatation during fill placement.
5. Field test reports shall be submitted within 48 hours of the completion of the test.

1.04 REFERENCE STANDARDS

A. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C. ASTM D75 Standard Practice for Sampling Aggregates
D. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
E. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

1.05 QUALITY ASSURANCE

A. Density: All references to "Maximum dry density" shall mean the maximum dry density defined by the "Maximum Density- Optimum Moisture Test," ASTM D698, unless otherwise specified. Determination of the density of backfill in-place shall be in accordance with the requirements of ASTM D2922, "Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)." The Contractor will provide for initial density testing of in-place backfill and all additional density testing of backfills found not to be within the minimum requirements of the Specifications.

B. One in place density and moisture test whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.

C. Additional gradation, Proctor, and maximum index density tests whenever the source or quality of material changes

D. For every 200 cubic yards of flowable fill placed, test four cylinders in accordance with ASTM C39. Two cylinders shall be tested at 3 days and the other two cylinders shall be tested at 28 days.

E. Sources and Evaluation Testing: Materials to be used for embedment and granular material to be used for select backfill shall be obtained in accordance with a sampling plan and ASTM D75, Sampling Aggregates. Testing of materials to certify conformance with the specification requirements shall be performed by an independent testing laboratory and paid by the Contractor. Contractor's testing agency shall perform tests upon change of source and at sufficient intervals to certify conformance of all select material furnished for use on this project.

F. Trench Width Dimension: The sides of all trenches shall be cut as nearly vertical as possible. The minimum and maximum widths of trenches, measured at an elevation twelve inches above the top of the pipe, shall be as shown on drawings. If the maximum width is exceeded at any point, the Contractor shall provide adequate support for the pipe as specified in Paragraph 3.01 C.3 of this Section.
1.06 SYSTEM DESCRIPTION/DESIGN REQUIREMENTS (NOT USED)

1.07 DELIVERY, HANDLING AND STORAGE

A. Excavated materials to be used for backfill may be deposited in stockpiles at points convenient for re-handling the material during the backfilling process. The location of stockpiles must be within the limits of construction easements or other locations coordinated and submitted by Contractor. The location of stockpiles is subject to the approval of the Owner or the Owner’s representative. Keep drainage channels clear of stockpiled materials.

1.08 MAINTENANCE/SPARE PARTS

A. Following completion of pipe laying, maintain paved surfaces, unpaved trench surfaces, fences, curbs, sidewalks, and gutters, for a period of twelve (12) months. Material and labor required for the maintenance shall be supplied by the Contractor, and the work shall be done in a manner satisfactory to the Owner’s Representative. Maintenance shall include repair of any trench settlement and any damages to structures or paving due to trench settlement or workmanship.

1.09 EXTENDED WARRANTY (NOT USED)

PART 2 PRODUCTS

2.01 CRUSHED ROCK

A. Crushed rock shall consist of sound and durable particles free from injurious amounts of salt, alkali, vegetable matter, or other material either free or as adherent coating. Its quality shall be reasonably uniform throughout.

B. Wear shall not exceed 40 percent when tested in accordance with TxDOT’s Standard Specifications for Construction of Highways, Street and Bridges Test Method Tex-410-A.

C. Gradation shall meet the following requirements for percentage by weight when tested in accordance with ASTM C136:

1. Standard Crushed Rock
   a. Passing 1-½-inch sieve .............................................. 100%
   b. Passing 1-inch sieve ............................................ 95-100%
   c. Passing ¾-inch sieve .............................................25-60%
   d. Passing No. 4 sieve ............................................ 0-10%
   e. Passing No. 8 sieve ............................................ 0-5%

2. Fine Crushed Rock
   a. Passing ½-inch sieve .............................................. 100%
   b. Passing ¼-inch sieve .............................................95-100%
   c. Passing No. 4 sieve ............................................ 40-65%
   d. Passing No. 8 sieve ............................................ 0-10%

D. Fine crushed rock shall be rounded or sub rounded particles. Fine crushed rock with sharp edges will not be accepted.

2.02 SELECT BACKFILL MATERIAL

A. Where select material is shown or specified, use an approved material, free of organic matter and foreign substances, obtained from an approved off-site source. The material shall have a plasticity index between 7 and 15 and a maximum liquid limit of less than 30 as determined by
ASTM D4318, and a maximum of 70 percent passing the No. 200 sieve. Prior to bringing any of the proposed material to the site, submit for review by the Owner’s Representative, an analysis of the proposed material, including a moisture-density relationship curve prepared in accordance with ASTM D698 by a certified independent testing laboratory employed and paid by the Contractor.

2.03 CEMENT STABILIZED SAND

A. Stabilized sand shall be mixed in the proportions of at least 282 pounds of Portland cement to each cubic yard of sand. Cement shall be as specified for cast-in-place concrete, Section 03 30 00. The cement stabilized sand shall be thoroughly mixed in a mechanical mixer and shall contain only enough water to produce an easily handled mixture.

2.04 FLOWABLE BACKFILL

A. Flowable material shall be a controlled density material consisting of cement and/or fly ash, sand and water meeting the following requirements:

1. High strength flowable fill: High strength flowable fill shall consist of an appropriate amount of cement (with other additives as necessary) mixed wet with mortar sand to flow and fill all voids in the excavation. This fill shall develop a minimum compressive strength of 2,160 pounds per square foot (15 psi) one hour after placement, and a 28-day compressive strength within the range of 300 psi to 500 psi. The material shall be such that it can be capped in 1 ½ to 2 hours.

2. Low strength flowable fill: Low strength flowable fill shall consist of an appropriate amount of cement (with other additives as necessary) mixed with mortar sand to flow and fill all voids in the excavation. This fill shall develop a minimum compressive strength of 1,120 pounds per square foot (7.8 psi) one hour after placement, and a 28-day compressive strength within the range of 25 psi to 100 psi. The material shall be such that it can be capped in 1 ½ to 2 hours.

B. Any materials used shall be primarily granular, with a plasticity index less than 12 and with 100% passing a 3/4” sieve.

2.05 FINAL BACKFILL

A. From 12-inches above the top of the pipe or conduit, the trench or excavation shall be backfilled with select material or excavated material free from rocks with any dimension greater than four inches unless otherwise specified or required elsewhere. The top 6-inches shall be the topsoil which has been placed separately.

B. Unless otherwise indicated on the drawings, no material of a perishable, spongy, or otherwise unsuitable nature, or excessively large rock (largest dimension greater than 4 inches), shall be used in backfilling.

2.06 CONCRETE FOR EMBEDMENT AND ENCASEMENT

A. Concrete embedment and encasement shall be Class "C" concrete with a minimum compressive strength of 2,000 pounds per square inch at 28 days.

2.07 MARKING TAPE

A. Non detectable:

1. For use above all metallic pipe.
2. Insert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.

3. Thickness: Minimum 5 mils.


5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.

6. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Mutual Industries; Non-detectable Tape.
   c. Presco; Non-detectable Tape.

B. Detectable: Not required.

Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

<table>
<thead>
<tr>
<th>Color</th>
<th>Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Electric power lines, cables, conduit, and lightning cables</td>
</tr>
<tr>
<td>Orange</td>
<td>Communicating alarm or signal lines, cables, or conduit</td>
</tr>
<tr>
<td>Yellow</td>
<td>Gas, oil, steam, petroleum, or gaseous materials</td>
</tr>
<tr>
<td>Green</td>
<td>Sewers and drain lines</td>
</tr>
<tr>
<td>Blue</td>
<td>Potable water</td>
</tr>
<tr>
<td>Purple</td>
<td>Reclaimed water, irrigation, and slurry lines</td>
</tr>
</tbody>
</table>

PART 3 EXECUTION

3.01 GENERAL

A. Topsoil: Topsoil and grass shall be stripped a minimum of six inches over the trench excavation site and stockpiled separately for replacement over the finished grading areas.

B. Demonstration Section:

1. Prior to beginning pipe laying operations for each embedment section, each pipe laying crew shall perform a demonstration section to validate that their methods and materials to be utilized will satisfy all project installation requirements including, but not limited to compaction requirements for the pipe foundation, pipe zone embedment, and trench zone in accordance with this Section and the Contract Documents.

2. The minimum length of the demonstration section shall be a single full length pipe joint and simulated bell excavation for each pipe laying crew. Pipe shall be embedded in accordance with this Section and then removed for Owner’s Representative to inspect and verify conformance to embedment requirements.

3. The Contractor shall not proceed with production pipe laying beyond the demonstration section without the Owner’s Representative’s approval.

4. The entire demonstration section length that does not comply with the Contract Documents shall be reworked as necessary to comply with all project requirements.
5. The Owner’s Representative will observe construction of the demonstration section.

6. The Owner’s Representative will take measurements and keep records for quality assurance purposes.

7. Any change in means, methods, and trench conditions, and backfill and compaction methods, and welding will require another successful demonstration section before additional production pipe installation.

C. Excavation

1. Trenches shall be excavated to the lines and grades shown on the Drawings with the centerlines of the trenches on the centerlines of the pipes. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible verification in pipe wall thickness.

2. The sides of all trenches shall be vertical to a point one foot above the top of the pipe. Unless otherwise indicated on the Drawings, the trench width shall be as shown on the drawings within a tolerance of +3 inches. Trench width will be measured at an elevation in the trench which is 12-inches above the top of the pipe when laid to grade.

3. Where the normal trench width below the top of the pipe is exceeded for any reason, the Contractor shall, unless the Owner’s Representative determines that the pipe being used is strong enough for the actual trench width, furnish an adequate support for the pipe. This may be accomplished by furnishing a stronger pipe or a concrete cradle, next higher class embedment or encasement, cap or envelope as approved.

4. The trenches shall be excavated to the required depth allowing for the placement of pipe bedding to the thickness shown on the Drawings. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.

5. Should the bottom of the trench become an unstable foundation for the pipe through the failure of the Contractor to adequately perform, the Contractor shall remove the unstable material and fill the trench to the proper subgrade with standard crushed rock.

6. Should the undisturbed material encountered at the grade depth constitute, in the opinion of the Owner’s Representative, an unstable foundation for the pipe, the Contractor is required to remove such unstable material and fill the trench to the proper subgrade with standard crushed rock. Depth of the standard crushed rock will be determined by the Owner’s Representative.

7. Bell (Joint) Holes: At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides where necessary to permit easy visual inspection of the entire joint.

8. Minimum pipe burial to the top outside surface of the pipe barrel shall be 5 feet unless otherwise noted.

3.02 TRENCH SAFETY SYSTEMS

A. Refer to Specification Section 31 41 33 Trench and Excavation Safety Systems.

3.03 DEWATERING EXCAVATIONS

A. Refer to Section 31 23 19 Dewatering.

3.04 EXCAVATED MATERIALS

A. Unless otherwise specified elsewhere, excavated material shall be placed adjacent to the work area and used for backfilling as required. Topsoil shall be placed separately in a careful manner
and replaced in its original position. Excess excavated materials shall be disposed of offsite in accordance with provisions of the Uniform General Conditions, General and Supplementary Conditions of the Contract.

3.05 EMBEDMENT

A. Embedment for Prestressed Concrete Cylinder Pipe, Bar Wrapped Cylinder Concrete Pipe, and Reinforced Concrete Pipe shall be Standard Crushed Rock.

B. Embedment for coated steel pipe, polyethylene wrapped ductile iron pipe and all plastic pipe shall be fine crushed rock.

C. Provide pipe bedding material under all pipe for the full width of the trench. Minimum depth of bedding material below the pipe barrel shall be as shown on the Drawings or as specified.

D. Minimum depth of pipe bedding material under the pipe bell shall not be less than 6 inches under normal trench conditions and not less than 6 inches in rock excavation areas. Minimum depth of pipe bedding material below the pipe shall be as shown on the drawings.

E. Placement:

1. Place the pipe bedding or foundation stabilization material for the full width of the trench in layers not exceeding 6 inches deep and compact each layer, until the material does not yield or move to the grade established for the pipe bedding. Where the distance to stable ground is excessive (more than two (2) feet), the Owner reserves the right to order as an extra, in writing, such other types of foundation or pipe supports as deemed necessary.

2. Particular attention must be given to the area of the pipe zone from the flow line to the spring line of the pipe to insure that firm support is obtained to prevent any lateral movement of the pipe during the final backfilling of the pipe zone.

F. Compaction

1. Compact embedment materials using vibration or mechanical tamping. Vibration methods shall limit vibration frequency and amplitude to avoid disturbance of adjacent in-situ soils.

2. All embedment materials, which includes material placed in trench bottom for pipe foundation, and all material within the pipe zone shall be compacted to a minimum of 95% of maximum dry density defined by ASTM D698 for cohesive material. For cohesionless material compact to a minimum of 75% of relative density as determined by ASTM D4253 and D4254, whichever is applicable.

3.06 CONCRETE EMBEDMENT AND ENCASEMENT

A. After pipe joints are completed, the voids at the joints in the embedment’s shall be brought to proper grade. Where concrete is placed over or along the pipe, it shall be placed in such manner as not to injure the joints or displace the pipe.

B. While placing concrete embedment and until the concrete sets up, each pipe shall be properly braced and held to grade so as to prevent any possible shifting or floating of the pipe.

C. Backfilling shall be done in a careful manner and no less than 24 hours after concrete embedment, cradle, thrust block, or encasement has been placed.

3.07 FINAL BACKFILL PLACEMENT

A. From 12-inches above the top of the pipe, or as shown on the Drawings, the trench or excavation shall be backfilled with select material or excavated material approved by the Owner’s Representative. No excavated material or excessively large rocks (largest dimension
greater than 4 inches) or debris of any sort are to be placed into the backfill. No appreciable weight of any sort, other than backfill, shall be allowed on the pipe until it has been covered to such a depth that damage to the pipe or joints will not occur. The top six (6) inches of backfill shall be topsoil free from rock outside of paved area.

B. Excavated material which is unsuitable for backfilling and excess material shall be disposed of in accordance with provisions of the Uniform General Conditions, General and Supplementary Conditions of the Contract.

C. Method of Consolidation:
   1. The Contractor shall provide a method of consolidation of material 12-inches or more above the pipe. Backfill material shall be compacted in layers from six to eight inches in thickness of loose fill. This material may be placed mechanically or by other means to provide at least 85% ASTM D698 of maximum dry density at 0 to 4 percent above optimum moisture or the compaction indicated on the Drawings. Where the soil PI is less than 20, the compaction moisture content shall be within ± 3% of optimum. Such material shall be tested and approved by the Owner’s Representative before continuing.

   2. The initial test section shall be a minimum of 100 lineal feet. Material not meeting required compaction shall be removed and replaced at no additional cost to the Owner. See Item 6 below for deep-fill requirements.


   4. Backfill under Road, Concrete Slabs, and Related Items. The backfill for trenches under roads, concrete slabs, and related items shall be compacted to 95% ASTM D698 of the maximum dry density at 0 to 4 percent above optimum moisture.

   5. Backfill in Structural Excavation Zone. The backfill for pipeline trenches located in the zone of excavation for structures shall be in accordance with 31 41 33 Trench and Excavation Safety Systems.

   6. Fill depths between 15’ to 25’ shall be compacted to 98% ASTM D698. Fill depths between 25’ to 35’ shall be compacted to 100% ASTM D698.

3.08 CONCRETE THRUST BLOCKING

A. Thrust blocks shall not be used to restrain fittings and joints for this project unless otherwise shown. Restrained mechanical joints or welded joints shall be provided on the pipe at all changes in direction, dead ends, valves, and reducers and where indicated on the Drawings.

3.09 FIELD TESTING

A. The in-place field density tests shall be determined by using a nuclear gage in accordance with ASTM D 2922. One test shall be taken on every other compacted lift at 800’ intervals for each pipeline. When backfill placement is under pavement, part of a roadway embankment, or within the influence zone of an existing structure, two tests shall be taken at random on every other compacted lift at each road crossing and intervals not to exceed 200 feet for each pipeline.

END OF SECTION
SECTION 31 25 00

EROSION AND SEDIMENT CONTROLS

PART I  GENERAL

1.01  SCOPE OF WORK

A. This Section pertains to the provisions for the control of erosion in the construction area and in stockpile areas including seeding and the construction of temporary swales as required and shown on the drawings. All areas where existing vegetation and grass cover have been bared by construction shall receive block sod or hydro-mulch and watered until growth is established. In developed areas where grass is present, block sod may be required.

B. Contractor is responsible for meeting all local, state and federal regulations regarding erosion control including the applicable provisions of the National Pollution Discharge Elimination System regulations from the Clean Water Act.

1.02  RELATED SPECIFICATIONS

A. Section 31 00 00 – Earthwork

B. Section 32 92 19 – Hydromulching, Seeding and Sodding

C. PRODUCTS

1.03  GRASS

A. Materials for seeding and sodding shall conform to Section 32 92 19 – Hydromulching, Seeding and Sodding.

1.04  FERTILIZER

A. Use commercial grade fertilizers to insure germination and growth.

B. Apply fertilizer in accordance with Section 32 92 19 – Hydromulching, Seeding and Sodding.

1.05  WATER

A. Use clean potable water for maintaining the grass.

1.06  SILT FENCE

A. Silt Fence shall conform to the requirements as shown on the Drawings.

1.07  HAY/STRAW BALES

A. Standard rectangular hay bales bound by baling wire or nylon or polypropylene strings.

B. Hay bales shall have a minimum of 30” in length and weigh a minimum of 50 lbs.

C. Hay bales shall be securely anchored in place with 3/8” dia rebar stakes, driven through the bales. The first stake shall be angled towards the previously laid bale to force the bales together.

1.08  SEDIMENT TRAPS

A. Standard manufacture designed to fit the intended inlet.
PART 2  PRODUCTS (NOT USED)

PART 3  EXECUTION

3.01  TEMPORARY SEEDING

A. Exposed fill and stockpile areas shall be seeded if the phasing of the construction operations are anticipated to leave the exposed fill and stockpile areas unattended for 6 weeks or more. Seeding operations shall be performed in accordance with 32 92 19 – Hydromulching, Seeding and Sodding. Broadcast seeding method shall be used unless otherwise instructed.

B. Areas designated on the drawings to be seeded shall be seeded in accordance to Section 32 92 19 – Hydromulching, Seeding and Sodding. Broadcast seeding method shall be used, unless otherwise instructed.

C. Areas to be seeded with slopes steeper than 10H:1V shall also utilize a soil retention blanket.

3.02  TEMPORARY SWALES

A. DESCRIPTION

1. Temporary drainage swales shall be provided as required to carry drainage away from the work area to an approved outfall point.

2. Unless otherwise shown on the drawings, swales shall be earthen "V" shaped channels graded to a sufficient depth and slope to carry the anticipated runoff, but at least two (2) feet deep with a slope of 1.0 %.

3. Swales not designated to remain in place at the completion of the contract shall be cleaned of any muck, debris and other unsuitable material and filled with approved fill before final grading operations begin.

4. Swales shall have erosion control barriers as required.

5. Permanent swales shall receive erosion control elements as shown on the drawings.

B. MAINTENANCE

1. During the course of construction all temporary swales constructed for this contract shall be maintained so as to allow proper drainage from the construction area. Before Contractor leaves the site at the end of construction, all temporary swales to remain shall be placed in good working condition.

2. Contractor shall work with other contractors at the site in maintaining existing swales and ditches.

3. Where necessary for access to the work areas, adequately sized culverts shall be installed and maintained to provide the access without disturbing the site drainage.

3.03  FILL AND CUT SLOPES

A. Fill slopes in all cases shall be no steeper than 3:1 unless specifically stated on the plans or approved by the Owner’s soils engineer.

B. When cut slopes exceed 2:1 for depths over three (3) feet, proper bracing and shoring per OSHA requirements shall be used and maintained.

C. For permanent slopes, cut or fill, between 2:1 and 10:1, erosion protection shall be provided with hydro-mulching, sod, seeding, or other method as approved.

END OF SECTION
SECTION 31 41 33

TRENCH AND EXCAVATION SAFETY SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Work in this section shall consist of furnishing all equipment, materials and labor for a trench and excavation safety system meeting appropriate requirements established in the Occupational Safety and Health Administration (OSHA) Safety and Health Regulations, Part 1926, Subpart P - Excavations, Trenching and Shoring, Texas HB 1569, and other applicable regulations.

1.02 RELATED WORK

A. Contract Documents:
   1. Section 31 00 00 – Earthwork
   2. Section 31 23 33 – Excavation, Trenching and Backfilling
   3. Section 31 50 00 – Excavation Support and Protection
   4. Section 31 23 19 – Dewatering

1.03 SUBMITTALS

A. Submit the following in accordance with the requirements of the General Conditions and Division 1 - General Requirements:
   1. The CONTRACTOR shall retain the services of a Professional ENGINEER, licensed in the State of Texas and having experience in soils engineering, to design and prepare the trench and excavation plans for all trench and excavations. The plans shall include shoring systems, systems to protect existing utilities, slope stability monitoring and dewatering.
   2. Submit a plan for all excavations of a depth 5 feet or greater, with a bottom width less than twice the total depth of the excavation, where an existing structure or utility falls within a 2 horizontal to 1 vertical (2:1) slope from the bottom of the excavation, or where conditions dictate a plan be developed based on the trench and excavation safety ENGINEERs analysis.
   3. Submit details of any proposed dewatering system including groundwater monitoring wells, slope stability and/or shoring systems to the OWNER prior to proceeding with any excavation.
   4. The CONTRACTOR should recognize that failure to dewater excavations prior to excavation to adequate levels below required excavation depths will result in a bearing capacity failure at the base of the excavation. If this occurs, the cost of repair of any excavation base failure will be charged to the CONTRACTOR. The CONTRACTOR must install an adequate number of groundwater monitoring wells in order to verify that adequate dewatering has occurred prior to beginning excavation.

1.04 PROTECTION OF FACILITIES

A. Before the start of earthwork operations, adequately protect utilities, structures, trees, shrubs and other permanent objects. Costs resulting from damage to permanent facilities due to negligence or lack of adequate protection will be charged to the CONTRACTOR. Excavations
near existing structures or utilities must be instrumented to verify no impact to existing facilities.

B. Provide surface drainage during the period of construction to protect the work and to avoid nuisance to adjoining property.

C. The CONTRACTOR shall conduct his operations in such fashion that trucks and other vehicles do not create a dirt nuisance in the streets. The truck beds shall be sufficiently tight, and shall be loaded in such a manner that objectionable materials will not be spilled onto the streets. Any dirt, mud, or other materials that are spilled onto the streets or deposited onto the streets by the tires of vehicles shall be promptly cleared away by the CONTRACTOR.

1.05 QUALITY CONTROL

A. Engineers responsible for design of trench safety systems, structural excavation plans and existing utility and structure protection systems shall be Professional Engineers licensed in the state of Texas. Such engineers must also demonstrate experience in soil mechanics, structural engineering and design of trench safety systems. Such engineers shall also submit to the Construction Manager certification of professional liability insurance coverage of at least $1,000,000.00. Such coverage must not exclude structural design or trench safety design.

B. ENGINEERs responsible for the preparation of the Trench Safety Plan shall meet the qualifications requirements of Quality Control section.

1.06 TRENCH AND EXCAVATION PLAN

A. Trench and Excavation Plan: After award, the CONTRACTOR shall have a trench and excavation plan prepared. This excavation plan must illustrate proposed trench safety and excavation requirements specifically designed for this project and must be designed, signed, dated and sealed by a Professional ENGINEER licensed in the State of Texas with professional experience in soil mechanics and design of trench safety systems. The CONTRACTOR is responsible for obtaining additional soil borings and soil analysis as required for design. The trench and excavation plan is to be designed in conformance with OSHA standards, Texas HB 1569 and other applicable regulations.

B. A signed, dated and sealed copy of the trench and excavation plan shall be maintained at the project site for the CONTRACTOR's use during construction. In addition, a signed, dated and sealed copy of the trench and excavation plan shall be maintained at the project site in the CONTRACTOR's records. No work in trenches or excavations in excess of five feet deep is to be performed until this plan is prepared and implemented. The CONTRACTOR shall not deviate from the trench and excavation plan without written authorization from the ENGINEER who prepared the trench and excavation plan. This written authorization shall be signed, dated and sealed by the ENGINEER. Any changes in the trench and excavation plan after initiation of construction will not be cause for extension of time or change order. CONTRACTOR accepts sole responsibility for compliance with all applicable safety requirements. The trench and excavation plan does not relieve CONTRACTOR from responsibility for any or all construction means, methods, techniques and procedures. Furthermore the CONTRACTOR shall indemnify the OWNER and Consulting ENGINEER from any and all claims due to any property damage or bodily injury (including death) that arises from use or misuse of the trench safety and excavation plan, or from CONTRACTOR's negligence in performance of the contract work.

1.07 DEFINITION
A. For the purposes of this project, a trench excavation is any excavation whose bottom width is less than twice the total depth of the excavation.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 GENERAL

A. Trench safety system shall be constructed, installed and maintained in accordance with the details shown in the design prepared by the CONTRACTOR's licensed Professional ENGINEER to prevent death or injury to personnel or damage to structures or utilities in or near these trench excavations. Unless otherwise specified elsewhere, materials excavated from trench to be stored no closer to the edge of trench than one-half the depth of the trench.

3.02 SUPERVISION

A. CONTRACTOR shall provide competent supervisory personnel at each trench while work is in progress to ensure CONTRACTOR's trench safety methods, procedures, equipment and materials meet the requirements of OSHA standards and the trench and excavation plan.

3.03 MAINTENANCE OF SAFETY SYSTEM

A. The safety system shall be maintained in the condition as specified by the CONTRACTOR's Trench Safety ENGINEER. The CONTRACTOR shall take all necessary precautions to ensure the safety systems are not damaged during their use. If at any time during its use a safety system is damaged, personnel shall be immediately removed from the trench or excavation area and the safety system repaired. The CONTRACTOR shall take all necessary precautions to ensure no loads, except those included in the safety system design, are imposed upon the excavation.

3.04 INSPECTION

A. CONTRACTOR shall make daily inspection of trench safety and excavation system to ensure that the system meets OSHA requirements and the requirements of the trench safety plan. Daily inspection is to be made by qualified personnel. If evidence of possible cave-ins, slides or other conditions of concern is apparent, all work in the trench shall cease until necessary precautions have been taken to safeguard personnel entering trench and protect adjacent structures and utilities. CONTRACTOR shall maintain permanent record of daily inspections. The CONTRACTOR's Trench Safety ENGINEER shall make periodic site visits (a: the start of each new excavation and at least once per week for all open excavations). Within two (2) days after each visit, the CONTRACTOR's Trench Safety ENGINEER shall make a written report to the OWNER certifying that the trench and excavation plan and safety construction practices are being followed. The CONTRACTOR's Trench Safety ENGINEER shall immediately report any unsafe construction practices to the OWNER and CONTRACTOR.

3.05 REMOVAL

A. Bed and backfill pipe to a point at least one foot above top of pipe prior to removal of any portion of trench safety system. Bedding and backfilling of the trench shall be performed in accordance with other applicable specification items. Backfilling and removal of trench supports shall progress together from bottom of trench upward. Remove no braces or trench supports until all personnel have evacuated the trench. Backfill trench to within five feet of natural ground prior to removal of entire trench safety system.

END OF SECTION
SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

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

1.02 SUMMARY
   A. Section includes temporary excavation support and protection systems.
   B. Related Sections:
      1. Division 31 Section 31 23 19 "Dewatering" for dewatering system for excavations.

1.03 PERFORMANCE REQUIREMENTS
   A. Design, furnish, install, monitor, and maintain excavation support and protection system
      capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and
      superimposed and construction loads.
      1. Delegated Design: Design excavation support and protection system, including
         comprehensive engineering analysis by a qualified professional engineer, licensed to
         practice in the state where the Project will be constructed, using performance requirements
         and design criteria indicated.
   B. As a minimum, the Excavation Support and Protection Plan shall address the following items:
      1. Provide details of shoring, bracing, sheet piling, soldier piles and lagging, tie backs, and
         other support systems and provisions for worker protection from hazards of caving
         ground.
      2. Methods and sequencing of installing excavation support.
      3. Proposed locations for excavated materials.
      4. Minimum lateral distance from the crest of slopes for vehicles, equipment, and stockpiled
         materials.
      5. Prevent surface water from entering excavations by grading, dikes, or other means.
      6. Install excavation support and protection systems without damaging existing buildings,
         structures, and site improvements adjacent to excavation.
      7. Monitor vibrations, settlements, and movements.

1.04 SUBMITTALS
   A. Delegated-Design Submittal: For excavation support and protection system indicated to comply
      with performance requirements and design criteria, including analysis data signed and sealed by
      the qualified professional engineer, licensed to practice in the state where the Project is
      constructed, responsible for their preparation.

1.05 PROJECT CONDITIONS
   A. Project-Site Information: A geotechnical report has been prepared for this Project and is
      available for information only. The opinions expressed in this report are those of geotechnical
engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. OWNER and ENGINEER will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.

2. The geotechnical report is referenced elsewhere in the Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify ENGINEER if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from OWNER and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.02 TRENCHES

A. For excavations exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and Federal requirements.
3.03 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section 31 00 00 "Earthwork."

2. Repair or replace, as approved by ENGINEER, adjacent work damaged or displaced by removing excavation support and protection systems.

B. If the support or stability of existing structures or site improvements is dependent, leave excavation support and protection systems permanently in place. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.

END OF SECTION
SECTION 329219

HYDROMULCHING, SEEDING AND SODDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Furnish all materials, sod, labor and equipment to perform all operations necessary to establish healthy, growing sod in the areas shown in the Plans and in accordance with the Specifications. Areas to be sodded include a 4-foot wide strip on either side of all new or modified concrete roads, sidewalks, mow strips, curbs, retaining walls, structures, areas around the landscaping and as shown on the Plans.

2. Hydromulch seeding of grass is required as shown on the Plans and in accordance with this Section. Establishment of a uniform, full-coverage of grass is required in all disturbed areas, and other areas indicated on the Plans. Hydromulch seeding is specified for these areas where grass establishment is required.

3. Hydromulch seeding includes mixing fertilizer, grass seed and mulch material with water and spraying the mixture onto tilled topsoil. Seeding includes spreading fertilizer, and grass seed onto tilled topsoil.

4. Furnish all materials, labor and equipment including watering system to establish full coverage grass where specified and to maintain the established areas for 60 days.

5. Seeding.

6. Hydromulch seeding.

7. Sodding.

8. Turf renovation.

9. Pesticide application.


11. Maintenance of seeded areas for designated time period.

B. Related Sections:

1. Section 311100 "Site Clearing and Grubbing" for topsoil stripping and stockpiling.

2. Section 310000 "Earthwork" and Section 312333 "Excavation, Trenching and Backfilling" for excavation, filling and backfilling, and rough grading.

1.03 DEFINITIONS AND REFERENCES

A. Definitions:

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, defoliants, or desiccants.

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. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

9. 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.

10. Turf: Short grass with earth bound to it by matted roots.


B. References:

1. ASTM International (ASTM):
   a. C602 - Specification for Agricultural Liming Materials
   b. D977 - Specification for Emulsified Asphalt
   c. D5268 - Specification for Topsoil Used for Landscaping Purposes

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. Certification of each seed mixture for turf grass sod. Include identification of source and name and telephone number of supplier.

3. Certification of each seed mixture for turf grass sod.

4. Fertilizer: Provide product manufacturer's name, warranty of producer, weight and analysis, and form of constituents.

5. Product Certificates: For soil amendments and fertilizers, from manufacturer.

6. Pesticides: Type, analysis, application information, and safety information.

B. Qualification Data: For qualified landscape Installer.
C. Material Test Reports: For existing native surface topsoil, existing in-place surface soil, and imported or manufactured topsoil.

D. Minutes: Preinstallation conference if applicable.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
   1. Professional Membership: Installer shall be a member in good standing of either the Professional Land care Network or the American Nursery and Landscape Association.
   2. Experience: Three years' experience in turf installation in addition to requirements in the General and Supplementary Conditions of the Contract.
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

B. Pesticide Applicator: State licensed, commercial.

1.06 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
   1. Seeding for erosion control: and/or permanent landscaping: see Tables 1-3
   2. Seeding for landscaping: Refer to Table 2.

B. Sod Application:
   1. Sodding may be performed between April 1 and October 1.
   2. Sod may be shipped in blocks or rolled sections of equal width.
   3. Sod materials shall be planted within 24 hours of harvest unless stored in approved manner.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.07 DELIVERY, STORAGE, AND HANDLING

A. 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. Deliver fertilizer in waterproof bags.
   3. Store packaged materials in dry locations.

B. Sod:
   1. Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and excessive moisture loss during delivery and storage.
   2. Sod shall not be dumped from vehicles. Damaged sod shall be rejected and removed from the site.
3. Prior to and after delivery during wet weather, allow sod to dry to the extent that will prevent tearing during handling and laying.

4. During dry weather, water sod to insure its vitality and prevent dropping soil during handling.

C. 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 and soil amendments with appropriate certificates.

1.08 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

   1. Sodded Turf:
      a. 90 days from date of planting completion during spring and summer.
      b. 90 days from date of planting completion during fall and winter.

PART 2 PRODUCTS

2.01 SEED

A. Grass Seed:

   1. Fresh, clean, dry, new-crop seed complying with requirements of Texas Seed Law. The seed packaged shall contain a Texas Testing Seed Label showing purity and germination, name, type of seed, and complies with Texas Seed law.

   2. Treated with fungicide.

   3. New crop seed harvested with 1 year prior to planting, free of other weed seed to the limits allowable under the Texas Seed Law.

   4. Seed shall have a germination and purity that will produce a live seed content of not less than 85 percent pure seed, and not more than 0.2 percent weed seed.

   5. Seed, which has become wet, moldy or otherwise damaged in transit or storage, will not be acceptable.

B. Seeding for Erosion Control: Provide seed from the previous season's crop meeting the requirements of the Texas Seed Law, including the testing and labeling for pure live seed (PLS = Purity x Germination). Furnish seed of the designated species, in labeled unopened bags or containers to the Engineer before planting. Use within 12 mo. from the date of the analysis. When Buffalo grass is specified, use seed that is treated with KNO3 (potassium nitrate) to overcome dormancy. (Use Tables 1 through 3 to determine the appropriate seed mix and rates as specified on the plans.)
Table 1 - Permanent Rural Seed Mix

<table>
<thead>
<tr>
<th>District and Planting Dates</th>
<th>Clay Soils Species and Rates (lb. PLS/acre)</th>
<th>Sandy Soils Species and Rates (lb. PLS/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Antonio (15) Feb. 1 - May 1</td>
<td>Green Sprangletop (Van Horn) 1.0</td>
<td>Green Sprangletop (Van Horn) 1.0</td>
</tr>
<tr>
<td></td>
<td>Sideoats Grama (South Texas) 1.0</td>
<td>Slender Grama (Dilley) 2.0</td>
</tr>
<tr>
<td></td>
<td>Texas Grama (Atascosa) 1.0</td>
<td>Hairy Grama (Chaparral) 0.6</td>
</tr>
<tr>
<td></td>
<td>Slender Grama (Dilley) 1.0</td>
<td>Shortspike WindmillGrass (Welder) 0.4</td>
</tr>
<tr>
<td></td>
<td>Shortspike Windmillgrass (Welder) 0.2</td>
<td>PinkPappusgrass (Maverick) 0.6</td>
</tr>
<tr>
<td></td>
<td>PinkPappusgrass (Maverick) 0.6</td>
<td>Plains Bristlegrass (Catarina Blend) 0.2</td>
</tr>
<tr>
<td></td>
<td>Halls Panicum (Oso) 0.2</td>
<td>Hooded Windmillgrass (Mariah) 0.3</td>
</tr>
<tr>
<td></td>
<td>Plains Bristlegrass (Catarina Blend) 0.2</td>
<td>Multi-flowered False Rhoades Grass (Hidalgo) 0.1</td>
</tr>
<tr>
<td></td>
<td>False Rhodes Grass (Kinney) 0.1</td>
<td>Arizon Cottontop (La Salle) 0.2</td>
</tr>
<tr>
<td></td>
<td>Hooded Windmillgrass (Mariah) 0.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arizon Cottontop (La Salle) 0.2</td>
<td></td>
</tr>
</tbody>
</table>

**Seed-mix available at Douglass King Seeds Co, San Antonio, TX. 210-661-4191**

Table 2-Temporary Cool Season Seeding

<table>
<thead>
<tr>
<th>Districts</th>
<th>Dates</th>
<th>Seed Mix and Rates (lb. PLS/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Antonio (15)</td>
<td>September 1 - November 15</td>
<td>Common Oats 100</td>
</tr>
</tbody>
</table>

*Information provided by Dr. Vanessa Corriher-Olson, Ph.D., Assoc. Prof./Forage Spec., Texas A&M.*

Table 3-Temporary Warm Season Seeding

<table>
<thead>
<tr>
<th>Districts</th>
<th>Dates</th>
<th>Seed Mix and Rates (lb. PLS/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Antonio (15)</td>
<td>May 1 – August 15</td>
<td>Brown Top Millet 25</td>
</tr>
</tbody>
</table>

*Information provided by Dr. Vanessa Corriher-Olson, Ph.D., Assoc. Prof./Forage Spec., Texas A&M.*

2.02  SOD MATERIAL

A.  Sod Requirements

1. Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted. Sod shall be at least 18 months old.

2. Living grass shall be interpreted to include grass that is seasonably dormant during the cold season and capable of renewing growth after the dormant period.
3. Sod and attached soil shall be free from noxious weeds, or undesirable plants, large stones, roots and other materials that might be detrimental to the establishment and future maintenance of the sod.

4. Mowed in production field to height neither higher than 4 inches nor lower than 1-inch within five days prior to removal.

5. Machine cut in sections not less than 2-1/2 feet in length not less than 12-inches in width and to a depth equal to growth of fibrous roots, providing a soil thickness of at least 3/4-inch and not more than 1-1/4 inches. Measurement for thickness to exclude top growth and thatch.

6. Cut in sections or strips strong enough to support its weight and retain size and shape when suspended vertically from firm grasp on upper 10 percent of section. Small, irregular or broken pieces of sod are prohibited.

7. Sod on Beck Roll is permitted.

8. Care shall be taken at all times to retain native soil on the roots of the sod during excavating, hauling, and planting.

B. Sod Species: Species to match rural seeding mix, as approved by OWNER; certified in accordance with State Certification regulations

2.03 FERTILIZER

A. Commercial Fertilizer: Commercial-grade, pelletized, uniform in composition, free flowing, and suitable for application with standard equipment. Fertilizer shall be of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium as suitable for the seed mixtures specified. Fifty percent of the nitrogen required shall be in the form of nitrate nitrogen, with the remaining may be in the form of urea nitrogen.

B. The fertilizer shall comply with the applicable State fertilizer laws and shall be delivered in bags or other convenient containers, each fully labeled and bearing the name, trademark, and warranty of the producer.

C. In the event it is necessary to substitute a fertilizer of a different analysis, it shall be palletized or granulated fertilizer, with the total amount of nutrients furnished and applied per 1000 square feet shall equal or exceed that specified for each nutrient.

D. Fertilizer which has become cakec or exposed to excess humidity or moisture will not be acceptable.

2.04 WATER

A. Water shall be fresh and free from injurious amounts of oil, acid, alkali, salts, or other materials harmful to the growth of the grass. Plant and/or service water may also be used as directed by the OWNER.

2.05 MULCHES

A. General: Consisting of straw, wood-fiber, mulch nettings, wood chips, compost, or other approved suitable material, free from Johnson grass and other noxious weed seeds.

B. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, barley, or other hay harvested before seed production. The straw mulch shall be kept dry and shall not be rotted or molded. A minimum of 50 percent by weight of the herbage comprising hay shall be in 10-inch length or longer.
C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Fiber mulch in paragraph above and nonasphaltic tackifier in first paragraph below are primarily used to protect hydroteaked areas from wind and water erosion during establishment.

E. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

F. Asphalt emulsion in paragraph below may be used as a tackifier in a hydroteaking slurry or to temporarily bond straw mulch in place.

G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.06 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.07 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

2.08 HYDROMULCH

A. Hydromulch Material
   1. Product and Manufacturer: Areas requiring grass establishment shall be Second Nature Hydroteaking Mulch as manufactured by Central Fiber Corporation, or approved equivalent.
   2. Mulch shall be manufactured of natural fiber stock free of plastics and foreign materials.
3. Mulch shall have a green non-toxic dye, disperse rapidly in water to form homogeneous slurry and shall remain in suspension. It shall have a water holding capacity of not less than 1300 grams water per 100 gram fiber.

2.09 PLANTING SOIL AND AMENDMENTS

A. Topsoil: Unless otherwise designated on the Drawings, comply with the topsoil requirements of Section 31 05 13 "Soils for Earthwork"

B. Amendments: As designated on the Drawings, add inorganic and organic amendments to on-site or off-site topsoil types to obtain acceptable planting soils

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. 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 ENGINEER and replace with new planting soil.

C. Examine areas and conditions, with Installer present, for compliance with requirements of site conditions and any other conditions affecting performance of the Work.

D. Examine seed and fertilizer before installation. Reject any seed or fertilizer that is wet, moisture damaged, or mold damaged.

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

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from Hydromulch seeding and hydromulching overspray.

2. Protect grade stakes set by others until directed to remove them.

B. 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.

3.03 TURF AREA PREPARATION

A. Limit subgrade preparation to areas to be planted.
B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. When applicable, apply initial fertilizer application directly to subgrade before loosening and blending topsoil.
   2. Thoroughly blend planting soil separately before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
      a. Delay mixing fertilizer with planting soil if planting will not proceed within 24-hours prior to seeding.
   3. Mix any required amendments with dry soil before mixing fertilizer.

C. Spread planting soil or topsoil to a depth of 4 to 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.
   1. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

D. Unchanged Subgrades: If turf is to be placed 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. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least 6-inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4-inches of soil. Till soil to a homogeneous mixture of fine texture.
   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 grass, vegetation, and turf, off OWNER'S property.

E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2-inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

F. Moistened prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

G. Smooth areas that have become gullied; and loosen or refill areas that have become compacted since completion of grading to a depth of 6 inches.

H. Before planting, obtain ENGINEER'S acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS
A. Prepare area as specified in "Turf Area Preparation" Paragraph 3.03
B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
C. Fill cells of erosion-control mat with planting soil and compact before planting.
D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.05 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two 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. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate as specified in Table 1 and Table 2 of the "Seed" Article.

C. Rake seed lightly into top 1/8-inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 3:1 with erosion-control blankets and 2:1 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

F. Mulching:

1. Protect seeded areas by spreading mulch material over seeded areas if construction was completed too late for planting a temporary fall crop or if insufficient residues are produced by the fall planting.

2. Protect seeded areas with slopes not exceeding 3:1 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

3. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.06 HYDROMULCH APPLICATION

A. Hydromulch Seeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for Hydromulch seeding application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with non-asphaltic or asphalt-emulsion tackifier for slopes 3:1 or steeper.

2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than rate listed below, and seed component is deposited at not less than the specified seed-sowing rate.

   a. Grades 2:1 or less: 2.5 lbs per 1000 Sq. Ft.

   b. Grades greater than 2:1: 3.0 lbs per 1000 Sq. Ft.

3. Mulch: As recommended by manufacturer.

B. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 1000-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry
cover coat of fiber mulch (hydromulching) at a rate to comply with the mulch component specified above.

C. For areas to be established, apply water with a fine spray immediately (within 24 hours) after each area has been seeded and mulched. Saturate to 4 inches of soil. Water daily as often as necessary for 4 weeks to establish grass.

3.07 SOD APPLICATION

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface.

C. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   1. Lay sod across angle of slopes exceeding 1:3.
   2. Anchor sod on slopes exceeding 2:1 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

D. After the sodding operations have been completed, the edges of the sodded area shall be smooth and shall conform to the contour of the adjacent area.

E. Saturate sod with water spray within two (2) hour of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod. Afterward, at a rate of 1-inch every four days unless rainfall precipitation is adequate.

3.08 FERTILIZER APPLICATION

A. Seeding and Hydromulch Seeding:
   1. Initial Fertilizer Application: Minimum rate of 15 lbs. per 1000 Sq. Ft. with Hydromulch mixture or as recommended by supplier and approved by OWNER.
   2. Second Fertilizer Application:
      a. Minimum rate 8 lbs per 1000 Sq. Ft. or as recommended by supplier and approved by OWNER.
      b. Period: Applied to the establishment areas between 45 and 60 days after date of seeding.

B. Sodding: Apply fertilizer uniformly at a rate of 18 lbs per 1000 Sq. Ft. or as recommended by supplier and approved by OWNER over all areas to be sodded.

3.09 AMENDMENTS APPLICATION

A. Apply amendments as designated and at the rate specified on the Drawings.

3.10 SEED PROTECTION

A. Cover seeded slopes where grade is steeper than 3:1 with erosion fabric. Roll fabric onto slopes without stretching or pulling. Cover hydromulched areas as recommended to obtain establishment of grass.

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B. Lay fabric smoothly on surface, bury top end of each section in 6-inch-deep excavated topsoil trench. Provide 12-inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

C. Secure outside edges and overlaps at 36-inch intervals with stakes.

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

F. No heavy equipment shall be moved over planted area unless area is to be re-tilled and reseeded.

3.11 TURF RENOVATION

A. Renovate existing turf.

B. Renovate existing turf damaged by CONTRACTOR'S operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
   2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6-inches

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4-inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch or sod as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.12 TURF MAINTENANCE REQUIREMENTS

A. Maintain and establish grass by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. 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. Replace materials and turf 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 turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water seeded area daily, keeping area moist until seeds have sprouted, then at a minimum rate of 1-inch every four days unless rainfall precipitation is adequate.
   3. Provide temporary irrigation systems in areas where permanent systems are not installed.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain a grass height of 1 to 2 inches.

D. Turf Post Fertilization: When specified, apply second application of fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer of the analysis and at the rate specified in "Fertilizers" Article to turf area after the first mowing.
   2. Prior to the second fertilizer application, CONTRACTOR shall reseed areas which show bare spots of 2 square feet or larger.

3.13 SATISFACTORY TURF
   A. Turf installations shall meet the following criteria as determined by ENGINEER:
   B. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 95 percent or 150 plants per square foot.
      1. Satisfactory Sodded Turf:
         a. At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
         b. Turf shall be firmly rooted so sections cannot be removed.
   C. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.
   D. Protect seeded areas with warning signs during maintenance period, if necessary.

3.14 PESTICIDE APPLICATION
   A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with OWNER'S operations and others in proximity to the Work. Notify 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 manufacturer's written recommendations.
3.15 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. 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 protecting newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION
SECTION 33 01 12

INSPECTION AND TESTING OF WATER UTILITIES

PART 1 GENERAL

1.01 SCOPE

A. Provide all necessary labor, materials and equipment, including test pumps and gauges, as well as temporary valves and piping to perform the testing operations of piping systems as specified herein.

B. If demonstrated workmanship on one or more tests show that lines are sufficiently watertight, the Engineer may waive remaining testing on any given type or section of line.

C. Contractor's Responsibility:
   1. Take such precautions as required to prevent damage to lines and appurtenances being tested.
   2. Repair any damage resulting from tests.
   3. Repair and retest all items which do not pass the tests as specified herein.
   4. Conduct all tests in the presence of the Engineer, and to the satisfaction of the Engineer and all State and local authorities having jurisdiction.
   5. All necessary pumps, water, pipe connections, meters, gauges, and any necessary apparatus to perform and conduct the tests shall be furnished by the Contractor. Contractor shall furnish all necessary equipment and make all tests at Contractor's expense without separate measurement and payment, but said expense shall be subsidiary to installation of pipe.

D. Water used for testing purposes shall be potable and/or non-potable water. Raw untreated wastewater (sewage) will not be allowed.

1.02 SUBMITTALS

A. Submit record data describing proposed testing methods, procedures, and apparatus for Engineer's record, prior to testing.

B. Submit a certified test report for each test to the Engineer certifying the location of the joint or section tested, the test pressures at the start and end of each test, duration of the test, leakage and pertinent observations and comments.

1.03 GENERAL SEQUENCE OF WORK

A. Submit for review the proposed testing methods, procedures, and apparatus, before performing any test.

B. Upon receipt of approved testing submittal, submit a schedule of testing dates and times at least 48 hours in advance of testing.

C. Perform tests as specified herein.
1.04 DEFINITIONS

A. "Gravity lines" shall refer to CCFRPM, clay pipe, reinforced concrete (non-cylinder-type) pipe, and other such pipes designed to normally operate in a partially full condition.

B. "Pressure lines" shall refer to CCFRPM, ductile iron, RCCP, steel, and other such pipes designed to operate in a full condition, with the system's energy grade line at or above the top of the pipe during normal operating conditions.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Test equipment shall be selected, obtained, and maintained by the Contractor. All gauges shall be calibrated prior to beginning testing and often as necessary to provide accurate, reliable information.

PART 3 EXECUTION

3.01 TESTING OF DRAINS, WASTEWATER, AND OTHER GRAVITY LINES

A. General:

1. For all pipes, the method of testing shall be either an exfiltration test or a low-pressure air joint test. For any flexible, non-metallic or non-concrete pipe, such as plastic (CCFRPM, PE, etc.) or fiber reinforced plastic pipe or similar flexible pipe materials, a deflection test shall be performed in addition to an exfiltration test.

2. Do not perform any test until backfill has been completed to proposed final grade.

3. Make first test promptly after first joint or section of line is laid and backfilled (as applicable). A section of pipe will normally be a run between two manholes, or between structures.

4. Do not lay additional piping of the type being tested until test of first section is complete.

5. Individual leaks will ordinarily be revealed by looking through sewer with a light while ground water level is over sewer, or immediately after water from exfiltration tests is emptied from sewer.

6. Settlement in backfill during exfiltration tests will be taken as an indication of leakage.

B. Low Pressure Air Joint Test:

1. All pipe joints shall be tested in accordance with ASTM C1103 as follows:

2. Equipment shall be the product of manufacturers having more than five years regular production of successful joint testers. Joint tester shall be as manufactured by Cherne Industrial, Inc., of Edina, Minnesota, or approved equal.

3. Testing shall be performed on all joints after backfill has been installed and properly compacted, and as installation progresses. At no time shall pipe installation exceed 100 feet beyond the last joint tested.

4. Joints failing to meet the requirements of this test should be repaired to the satisfaction of the Engineer or the defective pipe shall be replaced. Rejected pipe shall be removed from the project. Installation shall be stopped until defective joints are repaired or replaced.

5. Follow equipment manufacturer's recommendations when performing tests; only experienced technicians shall perform tests.
6. The testing equipment shall be assembled and positioned over the center of the pipe joint and the end element tubes inflated to a maximum of 25 psi.
7. Pressurize the center joint test area to 4.0 psig and allow the temperature and pressure to stabilize at the minimum of 2.5 psig for a period of 2.0 minutes prior to testing.
8. To test, adjust the pressure to 3.5 psig and measure the time required to decrease the pressure from 3.5 psig to 2.5 psig.
9. The joint is acceptable if the time for the pressure to drop from 3.5 psig to 2.5 psig is greater than 20 seconds.

C. Deflection Test
1. For all flexible and/or semi-rigid non-metallic, non-concrete pipe such as CCFRP, PE, FRP, PVC, etc., a deflection test shall be performed in addition to any other required leakage tests.
2. Two deflection tests using a mandrel will be required for each pipe segment after installation. The first deflection test shall be performed after the pipe has been completely installed and backfilled where a mandrel shall be pulled through the entire line segment to determine whether the maximum allowable percent of deflection has been exceeded. The first deflection test shall be performed a maximum of 800 feet behind pipe laying operations. A second test shall be performed following installation of the entire line but a minimum of three (3) months after installation and backfill for any section by pulling a mandrel through the entire line to determine whether the maximum allowable deflection percent has been exceeded.
3. The diameter of the mandrel shall be the maximum allowable percent deflection specified less than the inside diameter of the sewer line. The maximum allowable percent deflection shall be based on the nominal diameter. All mandrels and measurements shall be based on the nominal diameter [i.e., 42-inch nominal pipe diameter with a maximum 5 percent deflection requirement will have a maximum allowable 5 percent deflection of 2.1 inches (0.05 x 42 = 2.1); a mandrel outside diameter (minimum) of 39.9 inches (42 - 2.1 = 39.9); and a maximum deflection measurement of 2.1 inches].
4. In cases where the mandrel may hang due to excess deflection, the pipe shall be uncovered at this point and the conditions shall be corrected. Correction may be by reworking of the embedment and backfill, or by replacing that section of the pipe. This portion of the pipe shall again be backfilled, and the mandrel pulled through again, and this process repeated until the pipe is clear of all obstructions. The test shall be performed without mechanical pulling devices.

3.02 TESTING OF PRESSURE LINES

A. General
1. Allow concrete blocking to cure for at least 7 days before testing.
2. Backfill and compact soil behind all concrete blocking.
3. Backfill over pipe to extent necessary to restrain the piping. Backfill shall extend to within 1-foot of proposed final grade.
4. Conduct water leakage test after completing hydrostatic pressure tests.
5. Lines which fail to hold the specified test pressure for at least two hours, or which exceed an allowable leakage rate specified below, shall be repaired and retested at the Contractor's expense.

B. Procedures for Leakage and Hydrostatic Pressure Tests
1. Slowly fill isolated section of line with water.
2. Insure that all air has been expelled through air and vacuum release valves, taps, or connections shown on Plans for permanent piping, valves, or accessories. Do not make additional taps solely for air expulsion purposes unless approved by Engineer. No additional compensation will be made for additional taps.
3. Apply specified test pressure based on the elevation of the lowest section of line under test and corrected to elevation of test gauge. Duration of test shall be two hours.
4. Allow concrete pipe to stand full of water at least 12 hours before starting leakage test.
5. At the end of the two hours of the test, the entire route of the pipeline shall be inspected to locate any leaks or breaks. Any defective joints, cracked or defective pipe, fittings, or valves discovered in consequence of this pressure test shall be removed and replaced with sound material in the manner provided and the test shall be repeated until satisfactory results are obtained. Any and all noticeable leaks shall be repaired regardless of whether the actual leakage is within the allowable. The pipe shall be retested over a period of two hours.
6. All pipe shall be tested for leakage by a hydrostatic pressure test. Lines shall be filled slowly, with a maximum velocity of 1-foot per second, while venting all air. If permanent air vents have not been installed, the Contractor shall install corporation cocks at all high points to expel air during initial filling and testing of the lines.
7. The duration of each leakage test shall be two hours unless otherwise specified, and during the test the line shall be subjected to a continuous test specified pressure at the lowest elevation.
8. Leakage is defined as the net quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain pressure within 5 psi of the specified leakage test pressure after the pipe has been filled with water and the air in the pipeline has been expelled. No installation shall be accepted if the leakage is greater than that determined by the following formula:

\[ L = \frac{SD(P)^{0.5}}{133,200} \]

Where
- \( L \) = allowable leakage, in gallons per hour
- \( S \) = length of pipeline tested in feet
- \( D \) = nominal diameter of the pipe, inches
- \( P \) = average test pressure during the leakage test, psig

The test pressure shall be applied by means of a pump connected to the pipe and to an approved water container, or other approved method, for accurate measurement. The test pressure shall be maintained (by additional pumping, if necessary) for the specified time. While the line is under pressure, the system and all exposed pipe, fittings, valves, and hydrants shall be carefully examined for leakage. All defective elements shall be repaired or replaced and the test repeated until all visible leakage has been stopped and the allowable leakage requirements have been met.
9. On completion of tests, any newly installed, approved taps shall be tightly plugged with brass fittings.
10. Thoroughly purge all compressed air lines after testing.
3.03 TEST PRESSURES FOR PRESSURE LINES

A. All pressure pipelines (force mains, plant water, and potable water) shall be tested to 150 psi if not specified elsewhere. Process piping shall be tested at 50 psi if not specified elsewhere.

3.04 MANHOLE TESTING

A. Manholes shall be tested for leakage by hydrostatic exfiltration testing or vacuum testing. Manholes shall be tested after installation with all connections in place.

B. Hydrostatic Testing: The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour. Hydrostatic exfiltration testing shall be performed as follows: all wastewater lines coming into the manhole shall be sealed with an internal pipe plug, and then the manhole shall be filled with water, and maintained full for at least one hour. For concrete manholes a wetting period of 24 hours may be used prior to testing in order to allow saturation of the concrete. If the manhole fails the hydrostatic test, the manhole shall be repaired and retested until it passes the test.

C. Vacuum Testing: All lift holes and exterior joints shall be plugged with a non-shrink grout. No grout shall be placed in horizontal joints prior to testing. All pipes entering the manhole shall be plugged. Stubouts, manhole boots, and pipe plugs shall be secured to prevent movement while the vacuum is drawn. A minimum 60-inch-lb torque wrench shall be used to tighten the external clamps that secure the test cover to the top of the manhole. The test head shall be placed at the inside of the top of the cone section, and the seal inflated in accordance with the manufacturer’s recommendations. A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump shut off. With all valves closed, the time for the vacuum to drop to 9 inches of mercury shall not be less than 2 minutes. If vacuum tests are used in lieu of hydrostatic tests, the test shall be done both before and after backfilling of the manhole has occurred. If the manhole fails a test, necessary repairs shall be made with a non-shrink grout while the vacuum is being drawn. The test shall be repeated. If the vacuum test is failed twice, the manhole shall be repaired, and a hydrostatic test shall be performed in accordance with Paragraph 3.04.B of this Section. The manhole shall be retested as described above until a successful test is made.

END OF SECTION
SECTION 33 04 40

DISINFECTION OF POTABLE WATER FACILITIES

PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish all labor and materials required to disinfect the potable water facilities.

1.02  RELATED WORK

A. Division 33 – Utilities

B. Division 40 – Process Interconnections

C. Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment

D. Division 46 – Water and Wastewater Equipment

1.03  SUBMITTALS

A. A proposed plan and schedule for water conveyance, cleaning, disinfection and water disposal of disinfected water shall be submitted in writing prior to disinfection procedure and plan for disinfection of potable water facilities.

1.04  REFERENCE STANDARDS

A. American Water Works Association (AWWA)
   1. B300 - Hypochlorites
   2. C651 - Disinfecting Water Mains

PART 2  PRODUCTS

2.01  MATERIALS REQUIREMENTS

A. All equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment shall be selected and furnished by the Contractor.

B. Chlorine for disinfection may be in the form of sodium hypochlorite solution or calcium hypochlorite granules.

C. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of AWWA B300.

PART 3  EXECUTION

3.01  GENERAL

A. Disinfection operations shall be scheduled by the Contractor as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner.
3.02 PROCEDURES

A. Pipelines:
   1. During installation, the interior of all pipes, fittings and other accessories shall be kept as free as possible from dirt and foreign matter at all times. If, in the opinion of the Owner’s Representative, the pipe contains dirt or foreign matter that could not be removed during the flushing operation, the interior of the pipe shall be cleaned and swabbed with a bactericidal solution. When pipe laying is not in progress, the open ends of it shall be sealed with watertight plugs. If water has accumulated in the trench, the seal shall remain in place until the trench-water has been removed to such an extent that it will not enter the pipe.
   2. After completion of hydrostatic pressure tests and prior to disinfection, the pipeline shall be flushed, as thoroughly as possible with the water pressure and outlets available. If feasible, flushing rate should develop a velocity in the pipeline of at least 2.5 fps. If a velocity of 2.5 fps cannot be achieved, the requirements of Paragraph 3.02.A.1 above shall be rigidly enforced. The minimum quantity of water used for flushing shall be in excess of the storage capacity of the pipeline, to insure that clean water has traversed the entire length of line.
   3. After flushing has been completed to the point that apparent dirt and foreign matter have been removed from the pipeline, pipeline shall be disinfected in accordance with AWWA C651 as modified herein.
   4. The pipeline shall be disinfected using the Continuous-Feed Method or Slug Method. Minimum chlorine concentration shall be 50 mg/l for Continuous-Feed Method and 100 mg/l for Slug Method.
   5. Chlorinated water shall be retained in the pipeline for at least 24 hours for Continuous-Feed Method and 3 hours for Slug Method.
   6. After applicable retention period, the heavily chlorinated water shall be flushed from the newly laid pipeline at its extremities until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that prevailing in the system or is acceptable for domestic use.

3.03 WATER SOURCE

A. Unless otherwise indicated, water for disinfection will be furnished by the Owner; however, the Contractor shall make necessary provisions for conveying the water from the Owner designated source to the point of use.

3.04 BACTERIOLOGICAL SAMPLING AND TESTING

A. After final flushing and before the pipeline and structures are placed in service, a sample or samples shall be collected from the end of the line or the structure and shall be tested for bacteriological quality in accordance with the requirements of the State Department of Health or the appropriate regulatory agency having jurisdiction. For this purpose the pipe or the structure shall be refilled with the fresh potable water and left for a period of 24 hours before any sample is collected. Should the initial disinfection treatment fail to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained.

B. The Contractor will perform all sampling for bacteriological tests and will pay for all testing to be performed by Owner selected laboratory. All subsequent testing, should the initial test fail, shall be paid for by the Contractor.
3.05 CONNECTIONS TO EXISTING SYSTEMS

A. Where connections are to be made to existing potable water and filtered water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

3.06 DISPOSAL OF CHLORINATED WATER

A. Dispose chlorinated water in a manner that will protect the public and publicly used receiving waters from harmful or toxic concentrations of chlorine. Disposal shall be in accordance with Federal, State and local requirements.

B. Do not allow flow into a waterway without neutralizing disinfectant residual.

C. Refer to the appendix of AWWA C651 for acceptable neutralization chemicals.

END OF SECTION
SECTION 40 05 02
SPECIAL CONDITIONS FOR MECHANICAL WORK

PART 1 GENERAL

1.01 GENERAL

A. The work to be accomplished under these specifications includes all labor, materials and equipment required for the complete installation as described herein and as indicated on the mechanical drawings for the project. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1, Specification Sections, apply to the work of this section.

1.02 SPECIAL CONSIDERATIONS

A. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be provided as though shown and mentioned in both.

B. Coordinate the mechanical work with all other trades to determine whether there will be any interference by such trades with the mechanical work.

C. Investigate structural and finish conditions and arrange work accordingly, furnish all fittings and accessories required to meet conditions and give satisfactory operation. Coordinate with other subcontractors to avoid interference with their work. The right to make any reasonable change in the location of outlets, apparatus, and equipment up to time of roughing-in is reserved by the Owner’s Representative without involving any additional expense to the Owner.

1.03 SITE INSPECTION

A. All bidders submitting proposals for the work shall first examine the site and all existing conditions. The lack of specific information on the drawings shall not relieve the bidder’s responsibility for taking into account all site conditions in his proposal.

1.04 CODES, STANDARDS AND PERMITS

A. Work to conform to the latest editions of the following:
   1. ASHRAE.
   2. All applicable city, state and national codes.
   3. Requirements of local utility companies.
   4. Underwriter’s Laboratories, Inc., and shall be so labeled.
   5. NFPA.
   6. OSHA.
   7. Applicable AWWA Standards.
   8. Applicable ASTM Standards.

B. In case of difference between applicable codes, specifications, utility company regulations and the Contract Documents, the most stringent shall govern.
C. Obtain all permits, inspections and approvals applicable to the mechanical trade, as required by regulatory authorities. All fees and costs of any nature whatsoever incidental to these permits, inspections and approvals shall be assumed and paid. Obtain and pay for all the necessary certificates of approval, which shall be delivered to the Consulting Engineer before final acceptance of the work.

D. The Manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material.

1.05 SHOP DRAWINGS AND SUBMITTALS

A. Contractor shall submit shop drawings and submittal information in accordance with the General and Supplementary Conditions of the contract.

B. The Contractor shall submit complete information on all items in this division of the specifications where submittals are required to the Owner’s Representative for approval. Shop drawings and submittal information shall be clearly indexed and marked to indicate the proposed items of equipment.

C. The Contractor shall indicate in the submittals the actual operating characteristics of the proposed equipment at the specified design conditions. Submittals which are equipment brochures only and that do not clearly indicate capacities at scheduled conditions are not acceptable.

D. The review of submittals will be general in nature, and approval shall not be considered:
   1. As permitting any departure from the Contract requirements.
   2. As relieving the Contractor of the responsibility for any errors, including details, quantities, dimensions, materials, etc.

1.06 OPERATION AND MAINTENANCE MANUAL

A. Contractor shall submit Operation and Maintenance Manuals.

B. An operation and maintenance manual for each mechanical system and for each piece of equipment shall be furnished by the Contractor. The manual shall include, but not be limited to, the following:
   1. A system layout showing piping, valves, and controls.
   2. Wiring and control diagrams.
   3. A control sequence describing start-up, operation and shutdown.
   4. Installation instructions.
   5. Maintenance and overhaul instructions.
   6. Lubrication schedule including type, grade and temperature range, and frequency.
   7. Parts lists.
   8. Local Supply or otherwise.

1.07 MATERIALS AND MANUFACTURERS

A. Materials furnished shall be of best quality and grade of standard Manufacturer, shall conform to the National Board of Fire Underwriters requirements, and shall bear the Underwriters’ seal of approval.
B. Each item of equipment shall fit plan and space allowed and surrounding conditions and fulfill completely the function for which it is intended as well as item named on drawings or in specifications.

1.08 CONCRETE EQUIPMENT FOUNDATIONS, BASES, AND ROOF CURBS

A. All concrete equipment foundations, bases, and roof curbs as required for the installation of mechanical work hereinafter specified will be furnished and installed by the Contractor. The trade installing the mechanical sections of the work shall be responsible for the proper coordination of its equipment with these bases. Furnish all anchor bolts and other accessories required for casting in these concrete bases.

1.09 PROTECTION OF MATERIALS AND APPARATUS

A. At all times, the Contractor shall take such precautions as may be necessary to properly protect his apparatus from damage. This shall include the creation of all required temporary shelters to adequately protect any apparatus and the covering of apparatus in the complete building with tarpaulins or other protective covering.

1.10 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of equipment shown on the drawings is based on the dimensions of a particular Manufacturer. Where other Manufacturers are accepted, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit the space available. Shop drawings shall be prepared by the Contractor when required by the Owner’s Representative or Engineer to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces requiring access. Proper clearances shall be maintained to meet all safety and operating codes.

1.11 FLAME SPREAD PROPERTIES OF MATERIALS

A. All materials and adhesives used for air conditioning filters, acoustical linings and insulation shall conform to NFPA and UL life and safety and flame spread properties of materials. The composite classifications shall not exceed 25 for a flame spread rating and 50 for a smoke developed rating for these classifications as listed for the basic materials, the finished, adhesives, etc., specified for each system and shall be such when completely assembled.

1.12 RECORDS FOR THE OWNER

A. The Contractor shall keep a set of drawings on the job, noting daily all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new and uncovered existing utility piping outside the building and shall, with his request for final payment, turn over a clean, neatly marked set of reproducible drawings showing “As Installed” work to the Owner’s Representative for subsequent transmittal to the Owner.

B. In addition to the above, the Contractor shall accumulate during the job’s progress the following data, in duplicate, prepared in a neat brochure or packet folder and turned over to the Owner’s Representative for checking and subsequent delivery to the Owner.

1. All warranties, guarantees and manufacturer’s directions on equipment and material covered by the contract.

2. Approved wiring diagrams and control diagrams.
3. Copies of approved shop drawings.
4. Test and Balance report.

PART 2 PRODUCTS - NOT APPLICABLE

PART 3 EXECUTION - NOT APPLICABLE

END OF SECTION
SECTION 40 05 03

PIPING SPECIALTIES

PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish all labor and materials required and installed complete and ready for operation, all appurtenances as shown on the Drawings or as specified.

B. The appurtenances shall include, but not be limited to the following: (Note: All items listed below may not be required in this Contract).
  1. Yard Hydrants
  2. Mechanical Type Wall Seals
  3. Service Clamps
  4. Dielectric Insulating Gasket Kits for Flanges
  5. Dielectric Unions for Copper Tube
  6. Flange Bolts and Nuts
  7. Anti-Seize Bolting Lubricants
  8. Non-Insulating Flange Gasket Materials
  9. Sleeve ("Dresser type") Couplings
 10. Insulated Sleeve Couplings
 11. Flange Coupling Adapters
 12. Tie-Rod Restrained Dismantling Joints
 13. Depend-O-Lok Couplings
 14. AWWA Grooved-Joint Couplings
 15. Harnessing and Restraint
 16. Megalug Restrained Joints
 17. Quick Connect Couplings
 18. Wall and Floor Fittings
 19. Gauges and Accessories
 20. Valve Operators (Including Floor Boxes)
 21. Strainers
 22. Corporation Stops
 23. Appurtenances and Miscellaneous Items
 24. Emergency Safety Showers and Eyewash Units

1.02  SUBMITTALS

A. Shop drawings shall show as a minimum all details and materials of construction and dimensions.

B. Gasket manufacturer shall submit certificate that gasket material is suitable for the joints provided, service conditions specified herein and suitable for the field test pressure.

1.03  REFERENCE STANDARDS


B. American Society for Testing and Materials (ASTM):
1. A48 – Specification for Gray Iron Castings
2. A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
4. A183 - Specification for Carbon Steel Track Bolts and Nuts
5. A193 – Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
6. A194 – Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
7. A197 – Specification for Cupola Malleable Iron
9. A278 - Specification for Gray Iron Castings for Pressure Containing Parts for Temperatures Up to 650 degrees F
10. A283 – Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
13. B16 – Specification for Free-Cutting Brass Rod, Brass Rod Bar and Shapes for Use in Screw Machines
14. B62 - Specification for Composition Bronze or Ounce Metal Castings
15. B88 - Specification for Seamless Copper Water Tube
16. B584 – Specification for Copper Alloy Sand Castings for General Applications

C. American Water Works Association (AWWA):
   1. C209 – Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections and Fittings
   2. C210- Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
   3. C213 – Fusion Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipelines
   4. C219 – Bolted Sleeve Type Couplings for Plain-End Pipe
   5. C606 – Grooved and Shouldered Joints

D. Federal Specifications (F.S.): MIL-C-27487

I.04 QUALITY ASSURANCE
A. Items listed herein shall be products of Manufacturers who have a minimum of five years’ experience in the manufacture of the particular equipment item to be furnished.

B. Services of Manufacturer’s Representative
   1. Provide services of Depend-O-Lok coupling manufacturer’s factory service engineer specifically trained in the installation and adjustment of couplings as specified in this Section.
   2. Man-hour requirements shown in this Section are exclusive of travel time and do not relieve the Supplier of obligation to provide sufficient service to place couplings in satisfactory operation.
   3. Manufacturer’s factory service engineer shall submit Certificate of Proper Installation of Depend-O-Lok couplings.
PART 2  PRODUCTS

2.01  GENERAL
   A. Joint, size and material - unless otherwise noted or required by the Owner:
      1. Joints referred to herein shall be of the same nominal diameter as the pipe or fittings they are connected to.
      2. Appurtenances shall be of the same nominal diameter and same pressure rating as the pipe or fittings they are connected to.
   B. Insure that valves and appurtenances have ends/joints that are compatible with, and may be fastened to the adjoining pipe. This may mean furnishing special adaptors as required. These adaptors shall be suitable for direct bury, with proper dielectric insulation and as a minimum, if metallic non-stainless steel or galvanized, coated with two coats of Coal Tar Epoxy.
   C. Materials to be used in contact with the raw water or potable water process shall be classified as acceptable by NSF61.

2.02  YARD HYDRANTS
   A. Yard hydrants for installation on the non-potable water lines shall consist of a 3/4- inch hose connection. The hydrants shall be Woodford Model R34 Freezeless Hydrant or equal.

2.03  MECHANICAL TYPE WALL SEALS
   A. Mechanical type wall seals shall consist of an adjustable modular bolted, synthetic rubber and plastic sealing element as shown on Drawings. The sealing element shall be Link-Seal LS-300-C as manufactured by Enpro Industries, or equal.

2.04  SERVICE CLAMPS
   A. Service clamps shall have malleable or ductile iron bodies which extend around the circumference of the pipe. The saddle shall be sealed against the pipe with a rubber gasket. Bodies shall be tapped for IPS. Clamps shall be of the double strap design.
   B. Service clamps shall be IPS service clamps as manufactured by Mueller Co., or equal.

2.05  DIELECTRIC INSULATING GASKET KITS FOR FLANGES
   A. Dielectric insulating flange gasket kits shall be installed when dissimilar metal pipe connects to prevent galvanic action. Flange insulation kits shall be installed where a stainless steel flange is mated with flanges constructed of bronze alloys, carbon steel alloys, or nickel alloys (Monel and Hastelloy) flanges; where process piping mates with valves and other equipment and appurtenances of dissimilar metals furnished under Sections in Division 40 and 43: where exposed piping makes a vertical transition to buried piping; and where otherwise as shown on the Drawings.
   B. Insulating flange gaskets shall be furnished as a kit including the dielectric gasket, bolt sleeves and washers in accordance to the nominal flange size.
   C. Each dielectric insulating gasket shall be a full face isolating and sealing gasket, Type “E”, 1/8” thick, epoxy-glass retainer with bolt holes cut to match mating flange drilling. The retainer shall contain a precision tapered groove to accommodate the controlled compression of a FKM (Viton) sealing element. The quad-ring seal shall be pressure energized. The epoxy-glass retainer shall have 550-volts/mil dielectric strength and a minimum 50,000 psi compressive strength.
D. Insulating bolt-sleeves shall be manufactured of Mylar having a dielectric strength of not less than 4,000-volts/mil.

E. Insulating washers shall be manufactured of G-10 epoxy-glass having a dielectric strength of 400 to 500-volts/mil. Insulating washers shall be installed with metallic backing washers to prevent damage to the epoxy-glass washers during bolting. The metallic washers shall be constructed of the same material as the bolts.

F. Dielectric insulating flange gasket kits shall be:
   1. Linebacker manufactured by Pipeline Seal and Insulator, Houston, Texas.
   2. Trojan Quad Seal manufactured by Advance Products and Systems, Lafayette, Louisiana.
   4. Approved equal.

2.06 DIELECTRIC UNIONS FOR COPPER TUBE

A. Dielectric unions for copper water tube, ½-inch to 2-inch diameter, shall be installed where dissimilar metal connect to prevent galvanic action. The body shall be manufactured of ASTM B16 brass and feature female NPT threads adhering to ASTM B1.20.1 and solder joints adhering to ASME B16.22. Dielectric unions shall have Nitrile (BUNA) or EPDM gaskets and be rated for 250 psi at 180° F.

<table>
<thead>
<tr>
<th>Connection Type</th>
<th>Copper Alloy Pipe Connection</th>
<th>Joined Material Pipe Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soldered</td>
<td>ASTM B16</td>
<td>ASTM A48 Cast Iron*</td>
</tr>
<tr>
<td>Soldered</td>
<td>ASTM B16</td>
<td>ASTM A197 Malleable Iron*</td>
</tr>
<tr>
<td>Threaded</td>
<td>ASTM B584 Bronze</td>
<td>ASTM A48 Cast Iron*</td>
</tr>
<tr>
<td>Threaded</td>
<td>ASTM B584 Bronze</td>
<td>ASTM A197 Malleable Iron*</td>
</tr>
</tbody>
</table>

*Material may be galvanized

B. Acceptable Manufacturers:
   1. Watts, Andover, Massachusetts
   2. Wilkins, Paso Robles, California
   3. Approved equal.

2.07 FLANGE BOLTS AND NUTS

A. All flange bolt lengths shall be selected by the Contractor such that three threads, as a minimum, protrude from the hex nut and washer after assembly. Flange bolts for dielectric insulating flange kits shall be fully-threaded along their length. The Contractor is cautioned that flange bolts having smooth shank segments along their length will not fit in Mylar sleeves or molded sleeve washers.

B. All bolts, nuts, and washers in the locations listed below shall be Type 316 stainless steel as indicated below:
   1. All buried locations
   2. All submerged locations
   3. All locations subject to seasonal or occasional flooding
4. Inside Hydraulic Structures below the top of structures
5. Inside vaults, manholes, and junction structures
6. All chemical handling areas
7. Inside trenches, containment walls, and curbed areas
8. All locations exposed to weather
9. Locations indicated by the Contract Documents or designated by the Engineer to provide with stainless steel bolts.

C. Type 316 stainless steel flange bolts shall have ASME B1.1, coarse threads, Class 2A fit, and conform to ASTM A193, Grade B8M.

D. Flange nuts shall have ASME B1.1, coarse threads, Class 2A fit, and conform to ASTM A194 Grade 8M, Type 316 stainless steel, having square or hexagonal heavy dimensions in accordance with ASME B18.2.2. The hardness of nut shall be different than the hardness bolts to minimize galling.

E. For locations other than listed in Paragraph 2.07.B, flange bolts shall have ASME B1.1, Class 2A threads, and be manufactured of ASTM A193, Grade B7 steel. Bolts shall conform to ASME B18.2.1.

F. For locations other than listed in Paragraph 2.07.B, flange nuts shall have Class 2A fit, and be manufactured of ASTM A194, Grade 2H steel, having square or hex heavy dimensions in accordance with ASME B18.2.2.

2.08 ANTI-SEIZE BOLTING LUBRICANTS

A. Flange bolts shall be installed using a nickle-seize lubricant capable of achieving the required bolt torque and sealing stress, and permitting future disassembly with minimal manual input.

B. Anti-seize compound shall be classified as acceptable for potable water by the NSF.

C. Acceptable Manufacturers:
   1. Never-Seez White Food Grade PTFE Lubricant manufactured by Bostik, Wauwatosa, Wisconsin.
   3. Approved equal.

D. Flange bolts shall be adequately degreased of all corrosion inhibiting slush oil and excess nickle anti-seize prior to field application of prime and finish coatings.

2.09 NON-INSULATING FLANGE GASKET MATERIALS

A. Non-insulating gaskets for all flange configurations shall be submitted in accordance with Paragraph 1.02 of this Section. No field-cut or field modified gaskets will be allowed.

B. Gaskets shall be full face for use with flat face flanges and ring type for use with raised face flanges. Gaskets shall be 1/8-inch thick. Blind flange gasket shall cover entire inside surface of blind flange.

C. Gasket material shall be suitable for the joints provided, service conditions specified herein and suitable for field test pressure.

D. Gaskets shall be classified as acceptable for potable water service by NSF 61.

E. Gaskets shall be suitable for 250° F operating temperature, unless higher temperature required on individual systems.
2.10 SLEEVE ("DRESSER TYPE") COUPLINGS

A. Sleeve type couplings shall conform to the requirements of AWWA C219. The pressure rating of the couplings shall be at least the field test pressure it is subjected during the pressure testing of the connecting pipeline or the pressure class of the pipeline whichever is higher.

B. The couplings shall be of a gasketed, sleeve-type with diameter to properly fit the pipe. Each coupling shall consist of cylindrical sleeve, two follower rings, two gaskets and a set of bolts and nuts.
   1. Sleeve: Sleeve shall be ASTM A53, ASTM A512, ASTM A513, ASTM A536 Grade 65-45-12 or carbon steel having a minimum yield strength of 30,000 psi. Sleeve shall be lined with 12 mil DFT fusion bonded epoxy compatible with potable water. Minimum sleeve length shall be five inches for pipe 12-inches and smaller, seven inches for pipe sizes 14-inches thru 24-inches, and 10-inches for pipe larger than 24-inches. Sleeve for stainless steel piping shall be fabricated of ASTM A240, Type 316 stainless steel.
   2. Follower Rings: Ductile Iron ASTM A536 Grade 65-45-12, AISI C1012, AISI C1015 Steel, AISI C1018 Steel or AISI C1020 Steel. Follower rings for stainless steel pipe shall be fabricated of ASTM A240, Type 316 stainless steel.
   3. Bolts and Nuts: Bolts and nuts are as specified in Paragraph 2.07 of this Section.
   4. Gaskets shall be of synthetic rubber suitable for service and operating conditions.
   5. Finish: Fusion bonded epoxy 12 mil DFT as per AWWA C213.

C. Sleeve type couplings shall have pipe stop removed for exposed piping.

D. Acceptable Manufacturers:
   1. Dresser Industries - Style 38, 138, or 253.
   2. Romac Industries, Inc. - Style 400, 501, or XR501.

E. Sleeve type couplings shall be installed where shown on the Drawings and at locations where a disassembly gap is necessary to complete a piping assembly.

F. Contractor at his option may install additional couplings other than shown on the Drawings for ease of installations without any additional cost to the Owner.

G. In addition to those locations noted on the Drawings, sleeve couplings shall be provided on piping buried directly under a structure at the structure's expansion joints. Special treatment will be required where pipe is encased in concrete, utilizing minimum 3-inch thick styrofoam placed perpendicular to horizontal centerline coupling.

H. Joint harness shall be provided on all couplings and shall be designed for maximum test pressure to which the line will be subjected.

I. All sleeve couplings shall be thrust restraint.

2.11 INSULATED SLEEVE COUPLINGS

A. Couplings shall meet the basic requirements specified in Paragraph 2.10 of this Section.

B. Insulated sleeve coupling shall be Dresser Style 39, or equivalent Smith Blair or Baker. Insulated coupling shall include boots for both pipe ends, and shall insulate each end from electrical current flow. The middle sleeve ring shall be sized to fit over the insulation boots and properly seal the connection. Restraint sleeve couplings using a thrust harness with bolts, over drill the bolt holes and install insulating sleeves and washers.
2.12 FLANGE COUPLING ADAPTERS

A. Construction:
2. End Ring: Ductile Iron ASTM A536, Grade 65-45-12.
3. Flange: ANSI Class 125 or 250 flat face. Match class to that of piping system.
4. Bolts and nuts: As per Paragraph 2.07 of this Section.
5. Gaskets shall be of synthetic rubber suitable for service and operating conditions.
6. Pressure Rating: The pressure rating of the flange coupling adapters shall be at least the field test pressure it is subjected during the pressure testing of the connecting pipeline or the pressure class of the pipeline whichever is higher.

B. Restraining or harnessing system shall be as shown on the contract drawings for flange coupling adaptor.

C. Factory Painting:
1. Apply fusion bonded epoxy-type protective coating system in accordance with AWWA C213, to interior and exterior of adapters. Coating for interior surface shall be NSF 61 approved for potable water. Interior and exterior of flange coupling adapters shall have Manufacturer's standard epoxy system complete with prime and finish coats minimum of 12 mils DFT.
2. Do not paint bolts and gaskets.
3. Coatings used on exterior of couplings which will be exposed shall be compatible with specified coating system for piping so that coupling can be painted a common color.

D. Acceptable Manufacturers:
1. Size twelve inches and larger:
   a. Romac Industries, Inc. - Style FC400.
   b. Dresser Style 131.
2. Below twelve inches:
   b. Dresser Industries - Style 128-W.
   c. Smith Blair - Style 912.

2.13 DEPEND-O-LOK COUPLINGS

A. Depend-O-Lok split type bolted couplings shall meet the requirements of AWWA C219. Couplings type and size shall be as indicated on the Drawings. The pressure rating of the Depend-O-Lok couplings shall be at least the field test pressure it is subjected during the pressure testing of the connecting pipeline or the pressure class of the pipeline whichever is higher. Couplings shall pass an insulation test of 5,000 mega ohms.

B. Construction:
1. The housing shall be one or two-piece with a double arch cross section that closes around pipe ends that are smooth for joint flexibility or expansion and contraction requirements or pipe ends with steel restraint rings affixed for pipe end restraint requirements. Depend-O-Lok ExE couplings are flexible, unrestrained pipe joints. FxE couplings are flexible, expansion joints. FxF couplings are flexible, restrained joints. Flexibility, contraction and expansion and joint restraint are as specified in the Supplier's latest literature.
2. The housing shall be sized so that the inside diameter fits the outside diameter of the pipe. The coupling housing thickness shall be sufficient to handle the service loads.
3. Bolts or studs and nuts shall secure the closure plates and shall be as per Paragraph 2.07 of this Section.

4. Housing and closure plates shall be carbon steel conforming to ASTM A36 or stainless steel conforming to ASTM A240 Type 316L. Sealing plates shall be stainless steel conforming to ASTM A240 Type 316L.

5. Gaskets and sealing pad bonded to the sealing plate shall be of the synthetic rubber suitable for operating condition. Gasket material properties shall meet or exceed the requirements of ASTM D2000. Gaskets shall be classified as acceptable for potable water service by NSF 61.

6. Restraint rings shall be furnished with the couplings and shall be of the same material as the coupling housings.

7. Painting: Interior and exterior of carbon steel couplings shall be coated with liquid epoxy per the requirements of AWWA C210.

8. Buried couplings shall be protected against corrosion by providing heat shrink sleeves or cold applied tape conforming to AWWA C209.

C. Acceptable Manufacturers:
   1. Depend-O-Lok couplings shall be as manufactured by Victaulic Depend-O-Lok, Inc.
   2. Heat Shrink Sleeves shall be as manufactured by Canusa-CPS or Raychem.

2.14 AWWA GROOVED-JOINT COUPLINGS

A. AWWA rigid radius grooved-joint couplings for above grade ductile iron pipe, 4-inch to 36-inch diameter, shall be installed where shown on the Drawings. Grooved-joint couplings shall conform to AWWA C606 and constructed of ASTM A536, Grade 65-45-12 ductile iron.

B. Grooved-joint couplings, 4-inch to 36-inch diameter shall be:
   1. Style 31 AWWA coupling for ductile iron pipe manufactured by Victaulic Company.

C. Couplings for transition between ductile iron and IPS steel pipe, 4-inch to 12-inch diameter, shall be:
   1. Style 307 transition coupling manufactured by Victaulic Company.

2.15 TIE-ROD RESTRAINED DISMANTLING JOINTS

A. Tie-rod restrained dismantling joints shall be installed where shown on the Drawings and at locations where a disassembly gap is necessary to complete a piping assembly. Dismantling joints shall be constructed of ASTM A536, Grade 65-45-12 ductile iron or ASTM A283, Grade C carbon steel. Tie rods shall be 300 series stainless steel.

B. The pressure rating of the tie-rod restrained dismantling joints shall be at least the field test pressure it is subjected during the pressure testing of the connecting pipeline or the pressure class of the pipeline whichever is higher.

C. Apply fusion bonded epoxy-type protective coating system in accordance with AWWA C213, to interior and exterior of dismantling joints. Coating for interior surface shall be NSF 61 approved for potable water. Interior and exterior of dismantling joints shall have Manufacturer's standard epoxy system complete with prime and finish coats minimum of 12 mils DFT.

D. Acceptable Manufacturers:
   1. Dresser Industries – Style 131
   2. Smith-Blair – Model 975
   3. Romac Industries – Style DJ400
2.16 HARNESSING AND RESTRAINT

A. All flexible couplings, flanged coupling adaptors and dismantling joints shall be thrust restraint. The size and material for tie rods, clamps, plates, and hex nuts shall conform to AWWA Manual M-11 except as modified on the Drawings. Manufactured restraining clamp assemblies shall be as manufactured by Stellar Corporation or fabricated equal.

B. Pump manufacturer shall design thrust harness for pump suction and discharge piping in accordance with Hydraulic Institute Standards. Pump manufacturer shall provide this information to the Contractor. Contractor shall provide any and all restraints, exceeding those shown on the Drawings that are required by the pump manufacturer at no additional cost to the Owner.

C. Restrained joints (such as welded, locking mechanical joints) shall be of the type specified with the individual type of pipe. If not specified, restrained (locking) mechanical joints pipe shall be of the manufactures standard design utilizing a locking device (ring or ears) integrally cast with the pipe.

D. The Contractor shall be responsible for anchorage including restraint as noted in elsewhere in Division 33 and 40.

2.17 MEGALUG RESTRAINED JOINTS

A. Joint restraint devices for ductile iron and PVC pipe shall be Megalug as manufactured by EBAA Iron, Inc.

B. The devices shall have a working pressure rating same as the adjoining piping they connect to. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 for all pipe sizes.

C. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.

D. Three (3) test bars shall be incrementally poured per production shift as per Underwriter’s Laboratory specifications and ASTM A536. Testing for tensile, yield and elongation shall be performed in accordance with ASTM E8.

E. The restraint devices shall be coated using MEGA-BOND coating system.

2.18 QUICK CONNECT COUPLINGS

A. Couplings shall be of the cam and groove type consisting of a male adapter conforming to F.S. MIL-C-27487. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Connections shall remain tight and leak proof under pressures up to 100 psig. Each adapter shall be furnished with a dust cap complete with an 18-inch long security chain of corrosion resistant material. Couplings shall be as manufactured by Dover Corporation, Ever-tite, or equal.

B. Adapters shall be furnished in accordance with the Drawings or as required by the installation.

2.19 WALL AND FLOOR FITTINGS

A. Wall and floor castings, unless otherwise specified with the individual type of pipe, shall be ductile iron of the style shown on the Drawings with integral exterior water stop, standard models as manufactured by Clow, U.S. Pipe and Foundry, or equal.
B. For plastic pipe or other pipe 2-1/2-inch diameter or less wall and floor fittings shall be ASTM A120, Schedule 40 steel sleeves with exterior steel water stop, all hot dipped galvanized after fabrication.

2.20 GAUGES AND ACCESSORIES

A. All gauges unless otherwise noted be liquid filled and shall have 4-1/2-inch diameter face unless noted otherwise on Drawings, with black letters on a white background and protected in their connecting piping by shut-off corporation stops or metal ball valve with level or tee handle. Gauges shall be supplied with pulsation dampers on all pressure lines. On other than potable water and air lines, gauges shall also be supplied with three-way flushing valves and diaphragm seals. Gauges shall be Class 2A with 0.5 percent accuracy over their full range and shall be as supplied by U.S. Gauge, Ashcroft, or Marsh.

2.21 VALVE OPERATORS (INCLUDING FLOOR BOXES)

A. The valve Manufacturer shall supply and integrally mount all operators on valves at the factory. The valves and their individual operators shall be shipped as a unit.

B. Unless otherwise noted, valves shall be manually operated; non-buried valves shall have an operating wheel, handle or lever mounted on the operator; buried valves shall have a non-rising stem with an AWWA 2-inch nut.

C. Unless otherwise required by the Owner, all manual operating input shafts shall turn to the left (counter-clockwise) to open the valve.

D. Each operating device shall have cast on it the word (OPEN) and an arrow indicating the direction of operation.

E. Provide valve position indicator for buried valves. Valve box size shall be adequate to accommodate valve position indicator.

F. Floor boxes for operating nuts recessed in concrete floors shall be standard cast iron type, cast-in-place with fastening top by Clow or equal.

G. Chainwheel shall be supplied for all valves larger than 3-inch in diameter whose centerline is 6 ft. or more above the floor for operation of valve. Chainwheel shall be galvanized and chain shall loop within four feet of the floor. Chainwheel diameter shall match that of the handwheel.
   1. Acceptable Manufacturers:
      a. Babitt Steam Specialty, New Bedford, Massachusetts
      b. Roto Hammer Industries, Tulsa, Oklahoma
      c. Approved equal.

H. Unless otherwise noted, gear operators shall be provided for: All valves with operating shafts of larger than 8-inch nominal diameter (unless otherwise noted); for all buried valves with their operating shaft mounted horizontally (butterfly, plug, etc.); where specified and/or indicated on the Drawings; and where manual operator effort is greater than 40 ft-lbs. Gear operators shall normally be of the beveled type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on the output shaft. Gearing shall be machine-cut steel designed for smooth operation. Bearings shall be permanently lubricated, provided to take all thrusts and seals provided to contain lubricants. Housings shall exclude moisture and dirt. Manual operator input effort to the hand wheel shall be a maximum of 40 ft-lbs. to operate the valve from full open to full close, under line pressure. Gear operators shall indicate valve position and have adjustable stops.
2.22 STRainers

A. "Y" Type Strainers

1. Manual strainers furnished for pipe diameters smaller than 2 inches in diameter shall be "Y" type, capable of removing solids 0.01 inches diameter and larger. The strainer body shall be of semi-steel construction for steel pipe, and brass or bronze for copper pipe and shall conform to ASTM A278, Class 30. Strainers on plastic pipe shall be of the same material as the pipe. Strainer elements, including woven wire mesh, shall be constructed of Type 304 stainless steel.

2. Design of the strainer body shall be such that the clean-out plug and screw may be easily removed to permit inspection and cleaning without disassembly of inlet and outlet piping. End connections shall be ANSI screwed pipe threads.

3. Furnish one spare screen for each "Y" type units installed. Strainers shall be designed for a maximum operating pressure of 150 psig. They shall be as manufactured by GA Industries, Inc., or Watts Industries, Inc. or approved equal.

B. Manual Basket Strainers

1. Manual basket strainers shall be furnished for pipe 2 inches in diameter and larger, as per the Drawings. Strainer body shall be of cast iron construction. Strainer elements shall be constructed of Type 304 stainless steel. Design of the basket strainer body shall be such that the bolted lid and basket may be easily removed for inspection and cleaning without disassembly of inlet and outlet piping.

2. A trap with a blow-off port shall be provided for removing any material that may settle at the bottom. Strainers shall be designed for a maximum operating pressure of 150 psig, and shall be 74-D as manufactured by GA Industries, Inc., or Watts Industries, Inc., or approved equal.

3. Proper blow off piping with valve shall be supplied, run to nearest drain.

C. PVC Duplex Basket Strainer

1. Provide and install PVC duplex basket strainer as shown on drawings.

2. Strainer shall be of PVC construction, rated for a working pressure of up to 150 PSI. Baskets shall be removable without the need for tools.

3. Strainer shall be integrally fitted with PVC ball or butterfly valves to enable diversion of flow through either of the two baskets, while the other basket is isolated for cleaning. PVC ball valves shall be provided at each basket drain.

4. Strainer shall have two Type 304 stainless steel baskets, each with 1/16" perforations, providing a minimum open area ratio of 4:1.

5. Bolt bases securely to floor using 316 stainless steel capsule anchors.

6. Strainer shall be as manufactured by Hayward Flow Control Systems, or Eaton Filtration, or approved equal.

2.23 CORPORATION STOPS

A. Corporation stops shall be of bronze or brass, and shall be designed and manufactured in accordance with AWWA Standard C800, except as modified herein. Corporation stops shall have Mueller inlet threads, except that corporation stops for use with service clamps shall have IPS threads. Where corporation stops are used with plastic pipe, a brass companion flange shall be provided on the outlet of each corporation stop.
2.24 APPURTENANCES AND MISCELLANEOUS ITEMS

A. Plugs, caps and similar accessories shall be of the same material as the pipe, and of the locking type, unless otherwise noted.

B. Unions shall be of the same material as the pipe.

C. Special dielectric protective tape shall be fabric reinforced petroleum tape as manufactured by Denso, Inc., or equal.

2.25 EMERGENCY SAFETY SHOWERS AND EYEWASH UNITS

A. Furnish and install where shown on the Drawings. All assemblies shall be provided with stay-open ball valves. Provide eye wash with strainer on supply line. Units shall be complete with automatic flow control devices as required to limit emergency shower flow to 20 gpm and eye wash flow to 2.4 gpm. An emergency identification sign shall be included with each unit. Emergency safety shower and Eye Wash Assemblies shall be manufactured by Haws, Guardian, Western, Bradley, or Speakman.

B. Interior Emergency Shower/Eye Wash Unit
   1. Furnish and install a combination emergency shower and eye wash unit where shown on the Drawings.
   2. Units shall have a 10-in cyclocplastic shower head and eye wash bowl, stay open ball valves and hand and foot control for eye wash.
   3. Units shall be complete with automatic flow control devices as required to limit emergency shower flow to 20 gpm and eye wash flow to 3 gpm.
   4. Unit shall be equipped with a flow switch to provide a dry contact alarm signal when the unit is in use. The contact will be monitored by the plant SCADA system. Unit shall include strobe light and horn.
   5. Unit shall be modified to include a 8-ft hand held recoil hose assembly with bracket for spray head and equal to Haws Model #8906, Guardian Model #G1716 or Bradley Model #S-19-600

C. Exterior Freeze-Proof Emergency Shower/Eye Wash Unit
   1. Furnish and install where shown on the Drawings, a combination emergency shower and eye wash unit equipped with heating cable and insulation and designed to operate at temperatures as low as minus 40°F.
   2. Equipment shall include a ABS plastic shower head, stay-open ball valve, automatic volume control on both shower and eye wash, removable polyethylene foam insulation encased in ABS plastic jacket and a NEMA 4 enclosed thermostat. Shower flow shall be limited to 20 gpm. Eye wash shall include strainer, flow shall be 2.4 gpm.
   3. Unit shall have integral purge valve that opens when water temperature falls below 45°F. The valve shall be located opposite the water supply connection and purge approximately 6 gpm to prevent freezing in case of power failure.
   4. The unit shall be factory modified (special order) to include an additional 24-inch long section of heat trace wire exposed at piping inlet connection. Wrap heat trace wire around potable water supply from building. Insulate over heat trace and jacket outdoor exposed potable water piping.
   5. Unit shall be equal to Haws Model #8317CTFP. Other acceptable manufacturers are Guardian and Bradley, or approved equal.
PART 3 EXECUTION

3.01 INSTALLATION

A. Items shall be installed in strict accordance with Manufacturer’s instructions in the locations shown on Drawings. Damage to items shall be repaired to the satisfaction of the Owner before they are installed.

B. Install brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting items, check Drawings which have a direct bearing on their location to be responsible for the proper location of these appurtenances during construction of structures.

C. Items shall be carefully inspected for defects in construction and materials; debris and foreign material cleaned out of openings, etc.; operating mechanisms operated to check their proper functioning, and nuts and bolts checked for tightness. Equipment which does not operate easily, or is otherwise defective, shall be repaired or replaced.

D. Where installation is covered by a referenced Standard Specification, installation shall be in accordance with that Specification, except as herein modified.

E. Unless otherwise noted, joints for items shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint.

3.02 INSTALLATION OF SLEEVE (DRESSER) TYPE COUPLINGS

A. Unless otherwise required by the Manufacturer’s instructions, prior to installation of sleeve-type couplings, pipe ends shall be cleaned thoroughly for a distance of at least 12 inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end; the middle ring shall be placed on the already installed pipe and shall be inserted into the middle ring flaire and brought to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares.

B. After the bolts have been inserted and nuts have been made up finger tight, diametrically opposite nuts shall be progressively and uniformly tightened around the joint, by use of a torque wrench of the appropriate size and torque for the bolts.

C. The correct torque as indicated by a torque wrench shall not exceed 75 ft-lb for 5/8-inch bolts and 90 ft-lb for 3/4-inch bolts.

D. If a wrench other than a torque wrench is used, it should be no longer than 12 inches so that when used by the average person the above torque values shall not be exceeded.

E. To prevent sleeve-type couplings from pulling apart under pressure, a suitable harnessing or flange clamp assembly shall be provided and installed.

F. Note that the additional location requires sleeve couplings as specified in Part 2 of this Section.

3.03 INSTALLATION OF FLANGED COUPLINGS ADAPTERS

A. Flanged coupling adapters shall be installed in strict accordance with the coupling Manufacturer’s instructions in the locations shown on Drawings. After the pipe is in place and bolted tight, the proper locations of holes for the anchor studs shall be determined and the pipe shall be field-filled. Holes for anchor studs shall be drilled completely through the wall pipe. Hole diameter shall not be more than 1/8-inch larger than the diameter of the stud projection.
3.04 INSTALLATION OF DEPEND-O-LOK COUPLINGS
   A. Depend-O-Lok couplings shall be installed in strict accordance with the manufacturer’s instructions in the locations shown on Drawings. The coupling shall be assembled with bolts at the closure plates, tightened to assure snug coupling with the pipe.
   B. Manufacturer’s factory trained field representative shall instruct the Contractor’s field personnel for the calculation of pipe expansion and contraction based on temperature during field installation and design temperature to the joint for providing gap at the joint. The factory trained representative shall also instruct the Contractor’s field personnel for the installation of couplings. The coupling manufacturer shall provide these services for a minimum of eight hours in the field or shall be present during installation of first two (2) couplings whichever requires longer presence in the field.
   C. Manufacturer’s factory trained field representative shall submit the certificate of proper installation of couplings.

3.05 INSTALLATION OF TIE-ROD RESTRAINED DISMANTLING JOINTS
   A. Tie-rod restrained dismantling joints shall be installed in strict accordance with the manufacturer’s instructions in the locations shown on Drawings. Tie-rods must pass through the flanges on each end of the dismantling joint. Length of all tie rods shall be same.

3.06 INSTALLATION OF GROOVED JOINTS COUPLINGS
   A. Installation of AWWA grooved joint couplings and pipe shall be in accordance with the latest version of Manual I-300 "Field Installation Handbook for AWWA Products" published by Victaulic Company.
   B. Coupling gaskets shall be installed with the Victaulic lubricant compatible with the elastomer used. Lubrication of the gasket exterior, gasket sealing lips, housings, and pipe ends shall be done prior to joining to prevent gasket pinching.
   C. Coupling nuts shall be tightened evenly by alternating sides until metal-to-metal contact occurs at the bolt pads. For angle-bolt-pad couplings, even offsets must be present at the bolt pads to obtain pipe-joint rigidity.

3.07 INSTALLATION OF WALL AND FLOOR FITTINGS
   A. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as shown. Support all pipes embedded in concrete walls, floors, and slabs with form work to prevent contact with the reinforcing steel.

3.08 INSTALLATION OF OTHER EQUIPMENT, APPURTENANCES AND MISCELLANEOUS ITEMS
   A. Unions and wall fitting shall be installed as indicated on the Drawings.
   B. Hardware and appurtenances shall be installed as required and in accordance with the Manufacturer’s recommendations, as acceptable to the Owner.
   C. Use teflon tape on screwed fittings.

3.09 FIELD TESTING
   A. Testing and correction of deficiencies shall be in accordance with Section 33 01 12 – Inspection and Testing of Water Utilities.
3.10 FIELD PAINTING

A. Field painting is specified in Division 9. Buried metal items or those in vaults shall receive two coats of coal tar epoxy. The total DFT shall be 16 to 20 mils.

END OF SECTION
SECTION 40 05 07
HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, tools and related items required to furnish and install all pipe hangers, brackets, saddles, clamps and pipe rolls for all types of piping and duct systems. Pipe hangers and supports shall be furnished complete with all necessary inserts, bolts, nuts, threaded rods, washers and other accessories.

B. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility for providing them. Pipe supports indicated on the Drawings are shown only to convey the intent of the design for a particular location and are not intended to represent a complete system.

1.02 SUBMITTALS

A. Submittals shall comply with the General and Supplementary Conditions of the Contract. Submittals and Shop Drawings shall include complete layouts, schedules, location plans and complete total bill of materials for all pipe support systems.

B. Complete piping drawings indicating type of hanger and/or support, location, magnitude of load transmitted to the structure and type of anchor, guide and other pipe supporting appurtenances including structural fasteners.

C. Calculations showing size of supports using allowable stresses of material identified in MSS SP-58. All calculations shall be signed and sealed by a licensed professional engineer.

D. Submit product data and details on each support.
   1. Product data on each support and hanger component
   2. Detail of each different type of support
   3. Location of each pipe support
   4. Detailed information on anti-seize compound

1.03 REFERENCE STANDARDS

A. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
   2. SP-69 - Pipe Hangers and Supports - Selection and Application.

1.04 QUALITY ASSURANCE

A. Support System Design
   1. Engage the services of a professional engineer licensed in the state where the project is located. The professional engineer who is ordinarily engaged in the business of pipe support system analysis, to analyze system piping and service conditions and to develop a detailed support system, specific to the piping material, pipe joints, valves and piping appurtenances proposed for use.
   2. The support system shall include:
      a. Criteria by piping system.
      b. Summary of Contractor-selected related components including joints, class, valves, appurtenances etc., and commercial supports and especially including pipe materials.
c. Dead weight and dynamic analysis, including system thermal effects and pressure thrusts.

d. Support arrangements shall be coordinated to eliminate interference with similar systems to be installed under HVAC, Plumbing and Electrical; to account for structural expansion joints and to maintain access for both personnel and for the removal of equipment. Support systems shall not include use of monorail or bridge crane support. Nor shall they rely on the horizontal structural struts.

e. Commercial hardware and custom supports shall comply with the requirements of this Section.

B. Acceptable Manufacturers:
   1. Pipe Hangers and Channel Support Systems:
      a. Cooper B-Line Systems
      b. Grinnell/Anvil International
      c. Piping Technology & Products
      d. TOLCO a brand of NIBCO
      e. PHS Industries
      f. Unistrut/Tyco
      g. Powerstrut
   2. Powder-Actuated Fastener Systems:
      a. Hilti
      b. Red Head
      c. MasterSet Fastening Systems

1.05 DESIGN CONDITIONS

A. In certain locations, pipe supports, anchors, and expansion joints have been shown on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint. It shall be the Contractor's responsibility to design, furnish and install a complete system of pipe supports, to provide expansion joints, and to anchor all piping, in accordance with this section. Additional pipe supports may be required adjacent to expansion joints or couplings.

B. Concrete and fabricated steel supports shall be as indicated on the drawings, as specified in other sections or, in the absence of such requirements, as permitted by the Engineer.

C. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports with pipes full of fluid.

1.06 DELIVERY, HANDLING AND STORAGE

A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.

B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.

C. Finished metal surfaces not galvanized, that are not of stainless steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.
PART 2 PRODUCTS

2.01 GENERAL

A. Pipe hangers and supports shall be designed and constructed to meet the requirements of MSS SP-58 and SP-69.

B. The Contractor may propose minor adjustments to the piping arrangements in order to simplify the supports, or in order to resolve minor conflicts in the Work. Such an adjustment may involve minor change to the pipe centerline elevation so that a single trapeze support may be used. Supports shall be sufficiently close together such that the sag of the pipe is within limits that will permit drainage. Where ducts interfere with the proper location of hangers, furnish and install trapeze hangers.

C. Continuous slotted channels, channel struts and pipe clamps may be used to support multiple lines running in close proximity. Use expansion shields with bolts and horizontal drilled holes in existing concrete construction to support new piping.

D. When two (2) or more pipes run parallel, they may be supported by trapeze hangers.

E. Where flexible couplings are required at equipment, tank, etc., at the end opposite to the piece of equipment, tank, etc., shall be rigidly supported, to prevent transferring forces to the equipment. Fixed or restraining support shall not be installed between equipment and flexible coupling.

F. All uninsulated non-metallic piping such as PVC, CPVC, etc., shall be protected from local stress concentrations at each support point. Protection shall be provided by galvanized steel protection shields or 1/16-inch thick neoprene sheet. Where 360 degree arc support is required, such as U bolts, protection shields or 1/16-inch thick neoprene sheet shall be provided for the entire pipe circumference. Protection shields shall have an 18 gauge minimum thickness, not less than 12-inch in length and be securely fastened to pipe with stainless steel metal strap not less than ½-inch wide.

G. All insulated piping shall be furnished with a rigid foam insulating saddle at each pipe support location.

H. Where pipe hangers and supports come in contact with copper piping provide protection from galvanic corrosion by: wrapping pipe with 1/16-inch thick neoprene sheet material and galvanized protection shield; isolators or copper plated or PVC coated hangers and supports.

I. Provide neoprene isolators between the pipe and support components where dissimilar metals come in contact.

J. All vertical risers shall be supported by riser clamps or supports at each floor and every five feet. All vertical pipes passing through pipe sleeves shall be secured using a pipe collar.

K. Supports shall be provided at changes in direction. Changes in the direction shall be supported as close as practical to the fitting to avoid introducing excessive torsional stresses into the system. No piping shall be supported from other piping or from metal stairs, ladders and walkways unless specifically directed by the Owner’s Representative.

L. Whenever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. All components shall be structurally suitable to withstand all loads imposed. Effects of thermal expansion and contraction of the pipe shall be accounted for in the pipe support selection and installation.
2.02 MATERIALS

A. All hangers, brackets, clamps, hardware, etc. shall be Type 316 stainless steel unless noted otherwise. Do not use perforated strap hangers.

B. All pipe support assemblies including framing other than indicated below shall be galvanized steel.
   1. All submerged piping, as well as piping, conduits and equipment in hydraulic structures within 24-inches of water level shall be supported with support assemblies including framing, hardware, and anchors, constructed of Type 316 stainless steel.
   2. All piping in chemical and corrosive areas shall be supported with support assemblies including framing, hardware, and anchors constructed of Type 316 stainless steel or FRP.
   3. All outdoor piping shall be supported with support assemblies including framing, hardware, and anchors constructed of Type 316 stainless steel.

C. Metal Framing:
   1. Provide channels fabricated from not less than 12-gauge thick, 1-5/8” wide and not less than 1-5/8” deep.
   2. Use Type 316 stainless steel channels and components in all areas unless noted otherwise on drawings.

D. All anchor bolts shall be stainless steel as specified in Section 05 05 00 – Anchor Bolts. Space anchor bolts a maximum of 24-inches on center, with not less than two bolts per piece of framing.

E. Fiberglass Reinforced Pipe (FRP): Wear protection pad shall be used at each pipe support. It shall be designed in accordance with AWWA Manual M45. The wear protection pad material shall be as per the manufacturer’s recommendation and based on the application. It shall be from one of the following:
   1. Support Saddles manufactured by NOV Fiber Glass System, or equal.
   2. Blank or Wear Saddles manufactured by Ameron International, or equal.
   3. Wear pads manufactured by Conley, or equal.

F. All individually suspended horizontal pipes in the building shall be supported by stainless steel rods sized as follows:

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<thead>
<tr>
<th>Pipe Size (in Inches)</th>
<th>Rod Size (in Inches)</th>
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<tbody>
<tr>
<td>2 and smaller</td>
<td>3/8</td>
</tr>
<tr>
<td>2-1/2 - 3-1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>4 - 5</td>
<td>5/8</td>
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<tr>
<td>6</td>
<td>3/4</td>
</tr>
<tr>
<td>8 through 12</td>
<td>7/8</td>
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<tr>
<td>14 through 18</td>
<td>1</td>
</tr>
<tr>
<td>20 through 24</td>
<td>1-1/4</td>
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</tbody>
</table>
2.03 TYPE

A. Pipe hangers and supports shall be selected from one of the types shown on Figure 1 of MSS-58 and MSS-69 or as indicted on the drawing, where applicable. Plastic pipe support spacing shall be as specified in this Section and in accordance with the plastic pipe Manufacturer’s recommendations whichever is smaller.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pipe Support Spacing:

1. General:
   a. Pipe hanger and support installation shall comply with the requirements of MSS SP-69, MSS SP-89 and this Section. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
   b. Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems. Field assembled channel system shall be installed according to manufacturer’s written instructions.
   c. The pipe supports spacing shall not exceed the maximum span scheduled in Paragraph 3.01.A.1.g unless indicated otherwise.
   d. Provide at least one support for each length of pipe, at each change of direction, and at each valve or equipment.
   e. Locate pipe supports as shown in Table 3 of MSS-69 for piping not scheduled below or shown otherwise.
   f. Provide continuous support as required for small tubing to properly support the tubing along the pipe run and at connections to equipment.
   g. Pipe Support Schedule:
      (i) Steel, Stainless Steel and Cast-Iron Pipe Support Schedule:

<table>
<thead>
<tr>
<th>PIPE SIZES - IN (FT)</th>
<th>MAXIMUM SPAN (FT)</th>
<th>ROD SIZE - IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 and less</td>
<td>5</td>
<td>3/8</td>
</tr>
<tr>
<td>2½ thru 3½</td>
<td>10</td>
<td>½</td>
</tr>
<tr>
<td>4 thru 5</td>
<td>10</td>
<td>5/8</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>¾</td>
</tr>
<tr>
<td>8 thru 12</td>
<td>15</td>
<td>7/8</td>
</tr>
</tbody>
</table>

2. Copper Pipe Support Schedule:

<table>
<thead>
<tr>
<th>PIPE SIZES - IN (FT)</th>
<th>MAXIMUM SPAN (FT)</th>
<th>ROD SIZE - IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>2½ and less</td>
<td>5</td>
<td>1/2</td>
</tr>
<tr>
<td>3 thru 6</td>
<td>10</td>
<td>¾</td>
</tr>
<tr>
<td>8 and greater</td>
<td>15</td>
<td>7/8</td>
</tr>
</tbody>
</table>
3. PVC, ABS Pipe Support Schedule:

<table>
<thead>
<tr>
<th>PIPE SIZES - IN</th>
<th>*MAXIMUM SPAN (FT)</th>
<th>ROD SIZE - IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/4 and less</td>
<td>3</td>
<td>3/8</td>
</tr>
<tr>
<td>1-1/2 thru 3</td>
<td>4</td>
<td>1/2</td>
</tr>
<tr>
<td>4 and greater</td>
<td>5</td>
<td>3/4</td>
</tr>
</tbody>
</table>

*Maximum fluid temperature of 120°F.

Support spacing apply to continuous spans with no concentrated load.

B. Application:

1. Support piping approximately 1-1/2-inches out from the face of walls and at least three inches below ceilings.
2. Concrete inserts or L-shaped anchor bolts shall be used to support piping from new cast-in-place concrete. Epoxy or Expansion (as specified in Section 05 05 00) anchors shall be used to fasten supports to existing concrete and masonry.
3. Design loads for inserts, brackets, clamps, and other support items shall not exceed the Manufacturer's recommended loads.
4. Pipe supports shall be manufactured for the size and type of pipe to which they are applied. Threaded rods shall be sufficient threading to permit the maximum adjustment available in the support item.
5. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead ending. Anchors shall be located as required to force expansion and contraction movement to occur at expansion joints, loops or elbows, and as required to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints.
6. Pipe guides shall be provided adjacent to bellows type expansion joints. Guides shall be placed on both sides of expansion joints except where anchors are adjacent to the joints. Guides will not be required when mechanical couplings are permitted as expansion joints. Pipe supports shall allow adequate movement; pipe guides shall not be used for support. Pipe guides shall be installed as recommended by the Manufacturer.
7. Concentrated loads (valves, flanges, etc.) shall be supported directly or supported immediately adjacent to the load. Valves shall be braced against operating torque.

C. Adjustment: All hangers shall be adjustable. Wall hangers shall have slotted bolt holes. Ceiling hangers shall have turnbuckles. Floor supports shall have extended anchor bolts such that the support can be wedged to proper elevation and grouted. Provide a minimum of one inch of grout.

D. Pipe Rack: Pipe supported on pipe rack shall be supported on channels. Clamp pipes on the channel support by pipe clamps.

E. Touch Up:

1. Touch up all scratches or cuts on steel components with an approved zinc chromate or 90 percent zinc paint.
2. Use a PVC compound on PVC-coated components.
3.02 INSULATED PIPE
   A. Insulated pipe shall have protective saddles where supported. Insulation shall pass through the supports. Size supports for the full outside diameter of the insulation.

3.03 PLASTIC OR FIBERGLASS PIPE
   A. Plastic or fiberglass pipe shall have cradles and rubber pads to distribute the load over a length of at least six inches, or more if indicated on the drawings, at all supports.

END OF SECTION
SECTION 40 05 31.13

POLYVINYL CHLORIDE PROCESS PIPE

PART 1  GENERAL

1.01  SUMMARY

A.  The Contractor shall provide Polyvinyl chloride (PVC) pressure pipe, complete and in place, in accordance with the Contract Documents.

1.02  RELATED WORK

A.  Section 03 30 00 – Cast-in-Place Concrete

B.  Painting included in Division 9.

C.  Section 31 23 33 – Excavation, Trenching, and Backfilling

D.  Section 33 04 40 – Disinfection of Potable Water Facilities

E.  Applicable piping sections included in Division 33 and 40.

1.03  SUBMITTALS

A.  Submit shop drawings and product data for:
   1.  Piping layouts and schedules, including dimensioning, fittings, locations of valves and appurtenances, joint details, methods, and locations of supports.
   2.  All data and information required for the complete piping systems. Dimensions shall be on the actual equipment to be furnished.
   3.  Verifiable Certificate of Compliance with the NSF 61 Standard for all pipe and fittings.

B.  Prior to shipment of pipe submit certified test reports that the pipe for the Contract was manufactured and tested in compliance with ASTM and ANSI / AWWA Standards specified.

1.04  REFERENCE STANDARDS

A.  American National Standards Institute (ANSI)
   1.  ANSI A21.10 – Ductile-Iron and Gray-Iron Fittings, 3-in through 48-in, for Water and Other Liquids

B.  American Society for Testing and Materials (ASTM)
   2.  ASTM D 1785 – Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
5. ASTM D 2855 — Specification for Making Solvent – Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

1.05 QUALITY ASSURANCE

A. PVC pipe and fittings shall be from a single manufacturer. Inspection of the pipe will also be made by the Owner after delivery. The pipe shall be subject to rejection on account of failure to meet Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

PART 2 PRODUCTS

2.01 PVC PRESSURE PIPE

A. Pipe and fittings shall be manufactured from ASTM D1785.

B. Wall thickness shall be Schedule 80.

C. Fittings shall be socket-type conforming to ASTM D2467.

D. Pipe and fitting joints shall be of the socket type, designed for cold solvent welding conforming to ASTM D2564 and ASTM D2855.

E. Flat-faced flanges with troling pattern conforming to ANSI B16.5 Class 150 rated at 150 psi at 80°F.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: All PVC pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer. Contractor shall strictly follow manufacturer’s installation recommendations and requirements of this specification for assembly, chamfering of plain ends, applying solvents, and supporting pipe.

B. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 05 07 – Hangers and Supports for Process Piping. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion loops and guides shall compensate for pipe expansion due to temperature differences.

C. Valves and Unions: Unless otherwise indicated, all connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.
3.02 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. All pipe fittings shall be equally cleaned before assembly.

3.03 PIPE JOINTS

A. Solvent-Welded Joints: Solvent-welded joints shall be made with fresh cleaner, primer, and PVC solvent cement on clean, dry pipe ends in accordance with manufacturer recommendations for the specific piping application. It is the responsibility of the Contractor to confirm product compatibility and submit to the Engineer during the submittal process.

B. Flange Joints: Flanged joints shall be made with gaskets suitable for chlorine saturated water and Type 316 stainless steel bolts and nuts. Care shall be taken not to over-torque the bolts.

3.04 INSPECTION AND FIELD TESTING

A. Inspection: All finished installations shall remain undisturbed for 24 hours to develop complete strength at all joints and be carefully inspected for proper joints and sufficient supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Owner.

B. Field Testing: All piping systems shall be pressure tested as specified in Section 33 01 12. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. Leaks shall be repaired to the satisfaction of the Owner, and the system shall be retested until no leaks are found.

3.05 DISINFECTION OF PIPELINES

A. Pipelines designated to carry potable or utility water shall be disinfected in accordance with Specification Section 33 04 40.

END OF SECTION
SECTION 40 05 51
MISCELLANEOUS VALVES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor and materials required, and install complete and ready for operation, valves and appurtenances as shown on the Drawings and as specified.

B. The equipment shall include, but not be limited to the following: (Note: All items listed below may not be required in this Contract).
   2. Needle Valves.
   3. Pressure Regulating Valves.
   5. Ball Valves.
   7. Air/Vacuum Valves (For Water).
   8. Combination Vacuum Relief Air Inlet/Air Release Valves.
  10. Knife Gate Valves.
  11. Gate Valves
  12. Reduced Pressure Backflow Preventer.
  13. Duckbill Check valves.
  14. Diaphragm Valves
  15. Butterfly Valves

1.02 RELATED WORK

A. Pipe is included in the respective Section of Division 40.

B. Section 40 05 03: Piping Specialties

C. Section 40 05 07: Hangers and Supports for Process Piping

D. Certain valves and appurtenant equipment for individual systems are included with the specific system.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the General and Supplementary Conditions of the contract. The submittal shall show as a minimum all details and materials of construction and dimensions.

B. Submit operating and maintenance instructions as provided in the General and Supplementary Conditions of the contract.
C. Valves specified to be manufactured in accordance with AWWA and other standards must be submitted with an appropriate affidavit of compliance.

1.04 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
   1. ANSI B2.1

B. American Society of Testing and Materials (ASTM)
   2. ASTM B62 “Specification for Composition Bronze or Ounce Metal Castings.”

C. American Water Works Association (AWWA)
   1. AWWA C506 “Backflow Prevention Devices-Reduced Pressure Principle and Double Check Valve Types.”
   2. AWWA C504 “Rubber-Seated Butterfly Valves.”

1.05 DESCRIPTION OF SYSTEMS

A. All equipment and materials specified herein are intended to be standard for use in controlling the flow of water, air, wastewater, or chemicals, depending on the applications.

1.06 QUALITY ASSURANCE

A. Valves listed herein shall be products of manufactures that have a minimum of five (5) years of experience in the manufacturing of the particular equipment item to be furnished.

B. Valves of the same type shall be identical, varying only with size, and the product of one manufacturer.

1.07 TOOLS AND SPARE PARTS

A. Special tools and the manufacturer’s standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment as specified.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves and appurtenances shall have the name of the maker, flow directional arrows, size, and the working pressure for which they are designed, cast in raised letters upon appropriate part of the valve body.

B. Valves shall have a minimum working pressure of 150 psi or be the same working pressure as the pipe they connect to, and suitable for the pressures noted where they are installed.

C. Joints, size and material unless otherwise noted or required by the Engineer:
   1. Joints referred to herein shall be of the same type and material as the pipe or fittings they are connect to;
   2. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to;
3. Buried valves shall have mechanical joint ends unless noted otherwise on the Drawings.

D. Ensure that valves and appurtenances have ends/joints that are compatible with, and may be fastened to the adjoining pipe. This may mean furnishing special adaptors as required. These adaptors shall be suitable for direct bury, with proper dielectrically insulation and as a minimum, if metallic non stainless steel or galvanized, coated with two coats of Coal Tar Epoxy.

E. Buried valves and operators, and those located outdoors, particularly buried, or within maximum 2 feet above liquid, or in vaults or where noted shall be especially designed for service as if buried in the ground where water may completely submerge the valve and operator.

F. Valve operators shall be oriented as shown on the Contractor Drawings and/or as specified herein.

G. Except as otherwise shown on the Drawings or specified herein, all valves with operators located 6 feet or more above the operating floor shall be provided with chain wheel operators complete with chain guides and galvanized steel chain.

H. All buried valves shall open left (counter clockwise). Insofar as possible, all valves shall open counter clockwise.

2.02 GLOBE VALVES

A. Metal valves for plant air and water lines shall have a bronze body, renewable full plug stainless steel disc, renewable stainless steel seat, and 400 lb cold water non-shock working pressure, Globe valves shall be Figure 3245P as manufactured by Walworth Co., Jenkins Bros., or equal where copper tube with solder joints are required, globe valves shall be equal to Crane No. 1310 or 1311 as required.

B. Plastic valves shall be used only on PVC lines. Valves shall be socket welded and/or flanged as required. Valves shall have rigid PVC stem, body, bonnet, gland and cap nut with neoprene seat gasket and Teflon impregnated asbestos packing. The valve shall be able to be serviced in the line and shall be Ashai/America® or equal.

C. Valves shall be mounted as indicated on the Drawings or as acceptable to the Engineer.

2.03 NEEDLE VALVES

A. Needle valves shall have a cast bronze body and be constructed in accordance with ASTM B62. Ends shall be ANSI B2.1 threaded. The valves shall have a rising bronze stem and non-slip malleable iron hand wheel.

B. Needle valves shall be Figure 680 as manufactured by the Wm. Powell Company, Ohio, or Figure 88 as manufactured by Crane Company, or equal.

2.04 PRESSURE REGULATING VALVES

A. Pressure regulating valves shall be factory tested. Outlet pressure shall be easily field adjustable over the pressure ranges tabulated below.

B. Pressure regulating valves shall meet the criteria noted on the Drawings.
C. Pressure regulating valves shall have flanged connections, or shall have unions mounted in the pipe on each side of the valve.

D. Strainers for installation upstream of pressure regulating valves are specified elsewhere in Division 40. The pressure regulating valve manufacturer shall specify the screen mesh or size of perforations that are required to protect the regulating valve.

E. Pressure Regulating Valves – 3 inch and Larger:
   1. Valves 3 inch and larger and for pressure shall be flanged with globe body, fully bronze mounted, external pilot operated, diaphragm type single seat with seat base equal to size of valve and shall be equal to the Figure 4500D pressure Reducing Valve as manufactured by GA Industries, Inc., PA; or Cla-Val Model 90-01/690-01 as manufactured by Cla-Val Company, CA.
   2. The valve shall be packed with leather or some other material acceptable to the Engineer to insure tight closure and prevent metal to metal friction and sticking. The valve shall be furnished with indicator rod, to show position of opening of the piston, and pet cocks for attachment to valve body for receiving gauges for testing purposes.
   3. Pilot valve, controlling operation of main valve, shall be easily accessible and so arranged to allow for its removal from the main valve, while the main valve is under pressure. The pilot valve shall be easily adjustable without removal of the springs, weights or use of special tools. Control piping on the valves shall have strainers to prevent plugging of control mechanisms.
   4. Design shall be such that repairs or dismantling internally of main valve may be made without its removal from the line.
   5. The flanges shall have the same pressure rating as the connecting pipe. The valve body shall be constructed of cast iron.
   6. The valve shall maintain pre-adjusted downstream pressure for varying rates of flow through the positioning of the piston by the pilot without causing water hammer and without causing waste of water, and without cavitation.

F. Pressure Regulating Valves – 2 inch and Smaller
   1. Pressure regulating valves 2 inch and smaller shall be rated at the same working pressure as the connecting pipe, with bronze and brass body; renewable stainless steel seat, and flexible diaphragm of suitable material. Outlet pressure shall be easily field adjustable over the pressure ranges tabulated.
   2. Pressure regulating valves 2 inch and smaller shall be Figure No. 43D as manufactured by GA Industries, Inc., PA, or Cla-Val Model 90-01/690-01 as manufactured by Cla-Val Company, CA.

2.05 SOLENOID VALVES

A. Solenoid valves shall be packless piston type direct acting, 2-way or 3-way valves and shall be ASCO Valve Red Hat as manufactured by Automatic Switch Co., an equal by Atkomatic Valve Co., Inc., for air and water service.

B. Valves on water seal lines shall be of the normally closed type, interconnected with pumping unit to shut down if no seal water flow.

C. Valves shall have forged brass bodies, NPT end connections of the size shown on the Drawings, 300 or 400 series stainless steel internal parts, and Buna-N or Ethylene Propylene
valve seats. Valves shall have a same working pressure as the connecting pipe and zero minimum operating pressure differentials. Connections shall be threaded.

D. Except as otherwise specified, valves shall have NEMA 4 solenoid enclosures, shall be suitable for operation on a 120V, 60 Hz, single phase power supply, and shall be provided with a continuous duty Class F coil and a manual operator.

E. Solenoid valves on bypass piping shall be installed whether shown or not.

F. Note that solenoid valves may be shown on Electrical and/or Mechanical Drawings, or may only be specified.

2.06 BALL VALVES

A. Ball valves for PVC piping shall be of PVC Type 1, Grade 1, with true union, socket, threaded, or flanged ends as required. PVC ball valves shall be as manufactured by Spears Manufacturing, Nibco, or Hayward.

B. Ball valves, except otherwise specified, shall be of ductile iron body and Type 316 stainless steel ball and stem. The valve seat and body seal shall be of PTFE. Other hardware shall be of stainless steel Type 316. Valves shall have 150 psig (minimum) working water pressure. Valves shall have flanged or threaded ends as shown on the drawings, and shall be Model 7150/5150 as manufactured by Jamesbury, or an equal by Hills-McCanna.

C. Ball valves for copper piping shall be bronze body, brass stem and stem gland nut, chrome-plated brass ball, reinforced Teflon seats, stuffing box ring and thrust washer, and vinyl coated, or zinc or cadmium-plated steel handle with threaded or soldered ends as required. Valves shall have 150 psi minimum working water pressure. Valves shall be as manufactured by Jamesbury, Stockham, or Apollo.

D. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

E. Ball valves for chlorine and sodium hypochlorite services shall be vented.

2.07 AIR RELEASE VALVES

A. Valves shall be installed to release any small accumulations of air, which may collect while the main pipe is in operation and under pressure.

B. The small orifice assembly (Air Release Valve) shall automatically release air accumulations from the pipe while under positive pressure. When the valve body fills with air, the small orifice float ball falls to open the small orifice and exhaust the air to atmosphere. When the air has been exhausted, the small orifice shall be buoyed up and tightly close the small orifice.

C. The small orifice assembly shall be furnished with cast iron body and cover ASTM A126-B. The float ball shall be constructed of stainless steel and attached to a stainless steel lever mechanism. A resilient, Buna-N seat shall be attached to the lever mechanism for drop-tight closure.

D. Separate air release valves shall be Crispin, APCO, or Vameatic GA.
2.08 AIR/VACUUM VALVES (FOR WATER)

A. The large orifice assembly (air and vacuum valve) shall exhaust air from the pipeline during initial filling of the pipeline. The large orifice assembly shall not blow shut while exhausting air, even while venting air at sonic velocity. When air has been exhausted from the pipeline, the large orifice float ball shall be buoyed up to seat tightly against a resilient seat ring. The large orifice float ball shall remain tightly closed while the pipeline is under positive pressure. Should the pipeline pressure fall below atmospheric pressure, the large orifice float ball shall fall away from the seat ring and permit air to enter the pipeline.

B. The large orifice assembly shall be furnished with cast iron body and cover, ASTM A126-B. A resilient BUNA-N seat ring shall be affixed to the valve cover. The float ball shall be constructed of stainless steel with a minimum pressure rating of 1,000 psi. The float ball shall be free-floating within the valve body.

C. Unit shall be GA, APCO, or Valmatic.

2.09 COMBINATION VACUUM RELIEF AIR INLET/AIR RELEASE VALVE

A. Combination Vacuum Relief/Air Inlet/Air Release Valves (double body, double orifice) shall allow large volume air entry through the large diameter air inlet orifice, when vacuum occurs in a system, then close air tight trapping air, as the system returns to positive pressure. While the large orifice is closed, the smaller size air release orifice shall remain open, to slowly release trapped air in a controlled manner, to prevent water hammer and excess pressure surges. The small orifice shall operate (open) up to 300 psi. The size of the small orifice is shown on the Drawings.

B. The small orifice Air Release Valve shall operate with a compound level mechanism of stainless steel, actuated by a stainless steel float, designed to withstand 500 psi.

C. The Air Inlet Valve, internal plug and seat, shall be heavy cast brass; the seat retained in the body by a heavy cover; have a (molded not glued) resilient Buna-N seal, for positive shut-off and plug, center guided both ends, to prevent jamming. The plug shall be normally closed by means of a stainless steel spring and shall open when a vacuum pressure different exceeds 0.25 psi or less. The Combination Air Inlet Valve shall be rated 300 lb. Class.

D. The valve internals, shall be replaceable, without removing valve from the line and the materials of construction certified, conforming to following ASTM specifications:

<table>
<thead>
<tr>
<th>PART NAME</th>
<th>MATERIALS</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body, Cover</td>
<td>Cast Iron</td>
<td>ASTM A126 Gr. B</td>
</tr>
<tr>
<td>Baffle (1/2&quot;, 1&quot;, 2&quot;)</td>
<td>Delrin</td>
<td>ASTM D2133</td>
</tr>
<tr>
<td>Baffle (3&quot;)</td>
<td>Cast Iron</td>
<td>ASTM A48 Cl. 30</td>
</tr>
<tr>
<td>Plug &amp; Seat</td>
<td>Brass</td>
<td>ASTM B584</td>
</tr>
<tr>
<td>Exterior Paint</td>
<td>Phenolic Primer</td>
<td>FDA Approved for Potable Water</td>
</tr>
<tr>
<td></td>
<td>Red Oxide</td>
<td></td>
</tr>
</tbody>
</table>
Float                       Stainless steel       ASTM A240
Seat/Needle                 Buna-N                Nitrile Rubber
Spring                      Stainless steel       ASTM A276
Hood                        Galv. iron or steel  Commercial Grade
Lever Mech.                 Stainless steel       ASTM A351 T316

E. Combination Vacuum Relief/Air Inlet Valve/Air Release (Flanged Type) Valve shall be
   APCO, Crispin or equal.

2.10 SURGE CHECK VALVES (FOR USE WITH AIR VACUUM AND AIR RELEASE
   VALVES)

A. Surge check valves shall be installed on the inlet of the air vacuum and air release valve to
   eliminate a surge of water from prematurely closing or damaging the air release valve.

B. The valves shall be ANSI class 250 flanged, cast iron construction with bronze valve disc and
   seat ring and stainless steel spring.

C. The valve disc shall have drilled holes. These holes allow water to pass after the disc has been
   seated. The water slowly fills the air and vacuum valve to buoy its float and seal the valve. As
   the pressure equalizes, a stainless steel spring pushes the disc away from the seat to its original
   position.

D. Refer to Air Vacuum and Air Release Valve specifications for valve detail.

E. The materials shall conform to the requirements following:

   PART NAME   MATERIALS

   Body         Cast Iron ASTM A126 Class B
   Seat Ring    Bronze ASTM B62
   Valve Disc   Bronze ASTM B62
   Spring       Stainless Steel ASTM A313
   Bushing      Bronze ASTM B505

F. Product and Manufacturer
   I. The Manufacturer shall be the same as the Manufacturer selected for the air vacuum and
      air release valves. The model shall be per the Manufacturer’s recommendation.

2.11 KNIFE GATE VALVES

A. Type: Knife Gate Valve, bi-directional sealing.
B. Body Style: Wafer face-to-face, cast iron body, 316 stainless steel lined. Body for submerged service shall be 304 stainless steel.

C. Packing: Square braided PTFE impregnated synthetic fiber.

D. Operator: Chain.

E. Seat: EPDM or steel reinforced molded rubber.

F. Connections: Flanged for non-submerged, above grade service. Lugged ANSI 150 for submerged service.

G. CWP non-shock working pressure rating: 150 psi.

H. Acceptable Manufacturers:
   1. Fabri C67.
   2. Red Valve Company, Inc.
   3. Rovalve.
   4. Dezurik.

I. Port: Minimum of 95 percent.

J. Gate: Stainless steel.

K. Stem: Stainless steel.

L. Yoke: 304 stainless steel.

2.12 GATE VALVES

A. General
   1. Except as otherwise modified or supplemented herein, AWWA Standard C515-09 or the latest revision thereof, shall govern the design, component materials, construction; manufacture and testing of all resilient seated gate valves. Valves shall be suitable for frequent operation as well as service involving long periods of inactivity. Valves shall be NSF-61 certified.
   2. The Owner’s Representative reserves the right to limit the purchase of resilient seat gate valves from manufacturers to the models specified, provided such resilient seat valves conform to the provision contained herein.
   3. The minimum design working water pressure for gate valves with nominal diameters of 3 in., 4 in., 6 in., 8 in., 10 in., and 12 in. shall be 200 psig unless otherwise specified.
   4. The minimum design working water pressure for gate valves with nominal diameters of 16 in., and 20 in. shall be 150 psig unless otherwise specified.
   5. Valves shall be resilient-seated types, bronze mounted with non-rising stems. The closure member shall be fully encapsulated by an elastomer without thin spots or voids. When open the valve shall have a clear, fullport, unobstructed waterway.
   6. Gray iron, ductile iron, steel, brass and bronze materials shall meet or exceed the material requirements of Section 2: Materials of AWWA C515.
   7. Gaskets, O-rings, Coatings, and elastomers shall meet or exceed the material requirements of Section 2: Materials of AWWA C515.
8. The gate valves shall be designed and constructed for installation in either a horizontal or vertical position. Valves shall be designed for buried installation with stem in the vertical position and shall be furnished for mounting in a horizontal pipeline, unless otherwise specified.

9. Valve components of brass or bronze shall be manufactured to ASTM recognized alloy specifications of low zinc content bronze, as shown in Table 1 of Section 2.2.4. of ANSI/AWWA Standard C515 or the latest revision thereof. Materials for the stem have minimum yield strength of 40,000 psi. A minimum elongation in 2 inches of 12% and shall be made of bronze per ASTM B763, alloy number UNS C99500. A maximum zinc content of 2% as shown in Table 2 Chemical Requirements of ASTM B763-96 or the latest revision thereof. Stem nut material shall be ASTM B62 UNS C83600 or ASTM B584 UNS C84400. The stem shall have a visible external marking at the top to indicate low-zinc, high strength material. The marking shall include a red plastic or neoprene washer placed around the top of the stem under the operating nut.

10. Valve ends shall be flanged for above grade or in a vault, mechanical joint or push-on joint for buried service or any combination thereof, as specified. All mechanical joint valves shall be supplied with glands, bolts, and gaskets. Valve body bolts and nuts shall meet the strength requirements of ASTM A307 with dimensions conforming to ANSI B18.2.1. The size of the bolt head shall be equal to the size of the nut and shall be stainless steel in accordance with ASTM 276.

11. All gate valves shall open left (counter clockwise), unless otherwise specified.

12. The following parts of the valve shall be made of either gray or ductile iron: bonnet, body, yoke, wrench nut, O-ring packing plate or seal plate, and gland follower. The gate may be made of gray or ductile iron.

13. If glands and bushings are used for NRS valves they shall be made of ASTM B763 bronze UNS C99500. The stem shall be made of cast, forged, or rolled ASTM B763 bronze UNS C99500. The stem nut material shall be ASTM B62 bronze UNS C83600 or ASTM B584 bronze UNS C84400. The gate may be made of bronze ASTM B763 bronze UNS C99500. Stem seals shall be “O” ring type. The seals shall be designed for dynamic applications. The design shall be such that the seal above the stem collar can be replaced with the valve under full pressure in the fully open position. Materials for the “O” ring packing plate shall be in accordance with Section 4.8.3 of the ANSI/AWWA C515-09 Standard or the latest revision thereof.

14. Enclosed and buried valves shall be coated inside and outside with a fusion bonded epoxy having a nominal 8 mils dry film thickness, which meets or exceeds AWWA C550-01 and to the maximum extent possible shall be free of holidays. All coatings in contact with the potable water shall be approved for potable water immersion service per ANSI/NSF Standard 61.

15. All gate valve parts shall be designed to withstand the following two pressure requirements, without being structurally damaged. (1) An internal test pressure of twice the rated design working pressure of the valve. (2) The full rated internal working pressure when the closure member is cycled once from a fully open to a fully closed position against the full rated unbalanced working water pressure. In addition to these pressure requirements, the valve assembly and mechanism shall be capable of withstanding an input torque as follows: 200 ft.-lbf. for a 3-in. nominal diameter. 200 ft.-lbf. for a 4-in. nominal diameter. 300 ft.-lbf. for a 6-in. nominal diameter. 300 ft.-lbf. for a 8-in. nominal diameter. 300 ft.-lbf. for a 10-in. nominal diameter. And 300 ft.-lbf. for a 12-in. nominal diameter. For sizes larger than a 12 in. nominal diameter refer to the manufacturer’s specifications.
16. Resilient seats shall be applied to the gate and shall seat against a corrosion resistant surface. The non-metallic seating surface shall be applied in a manner to withstand the action of line fluids and the operation of the sealing gate under long-term service. A metallic surface shall have a corrosion resistance equivalent to or better than bronze. A non-metallic surface shall be in compliance with ANSI/AWWA C550. The gate must be fully encapsulated by an elastomer without thin spots or voids. Resilient seats shall be bonded. ASTM D429 either method A or method B shall prove the method used for bonding or vulcanizing. For method A, the minimum strength shall not be less than 250 psi. For method B, the peel strength shall be 75 lb./in.

17. Flanged Ends: The end flanges of flanged valves shall conform to dimensions and drillings of ANSI/AWWA C110/A21.10 or ANSI B16.1, Class 125.

18. Mechanical Joint Ends: Mechanical joint bell dimensions shall conform to ANSI/AWWA C111/A21.11.


20. All interchangeable parts shall conform to their required dimensions and shall be free from defects that could prevent proper functioning of the valve. When assembled, valves manufactured in accordance with this standard shall be well fitted and shall operate smoothly. All like parts of valves of the same model and size produced by the same manufacturer shall be interchangeable.

21. All castings shall be clean and sound, without defects that will weaken their structure or impair their service. Plugging, welding, or repairing of cosmetic defects is allowed. Repairing of structural defects is not allowed. Repaired valves shall comply with the testing requirements of this specification after repairs have been made. Repairs within the bolt circle of any flange face are not allowed.

22. All gate valves shall be hydrostatically tested with twice the specified rated pressure applied to one side of the gate and zero pressure applied to the other side. The test is to be made in each direction across the gate. All tests are to be performed at the manufacturer’s plant.

23. All gate valves shall be operated through a complete cycle in the position for which it was designed to ensure free and proper functioning of all parts in the intended manner. Any defects in workmanship shall be corrected and the test repeated until satisfactory performance is demonstrated. All tests are to be performed at the manufacturer’s plant.

24. A hydrostatic test pressure equal to twice the rated working pressure of the valve shall be applied to all assembled valves with the gates in the open position. The test shall show no leakage through the metal, pressure containing joints, or stem seals. All tests are to be performed at the manufacturer’s plant.

25. A test shall be made from each direction at rated working pressure to prove the sealing ability of each valve from both directions of flow. The test shall show no leakage through the metal, pressure containing joints, or past the seat. All tests are to be performed at the manufacturer’s plant.

26. Markings shall be cast on the bonnet or body of each valve and shall show the manufacturer’s name or mark, the year the valve casting was made, the size of the valve, and the designation of working water pressure, for example “200 W”.

27. Shop Coating:
   a. All interior and exterior ferrous surfaces of the valve, including the disc, shall be coated with epoxy, N.S.F. 61 certified. The epoxy shall have a nominal thickness of 8 mils, and shall be in accordance with AWWA C550, latest revision
   b. Coating shall be holiday tested and holiday free in accordance with AWWA C550.
B. Fabrication
   1. All parts of the resilient seat gate valve shall be designed and manufactured to the tolerances specified in ANSI/AWWA C515-09 or latest revision thereof and this specification.
   2. All parts of the resilient seat gate valve manufactured by a given manufacturer shall be interchangeable with like parts from another resilient seat gate valve of the same model and size and by the same manufacturer.
   3. All interchangeable parts shall conform to their required dimensions and shall be free from defects that could prevent proper functioning of the valve.
   4. All castings shall be clean and sound, without defects that will weaken their structure or impair their service. Plugging, welding, or repairing of cosmetic defects is allowed. Repairing of structural defects is not allowed. Repaired valves shall comply with the testing requirements of this specification after repairs have been made. Repairs within the bolt circle of any flange face are not allowed.
   5. The resilient seat gate valves shall be well fitted.
   6. Operation of the resilient seat gate valve shall be smooth.
   7. All parts shall be free of structural defects.
   8. The resilient seat gate valve shall be watertight.

C. Acceptable Manufacturers:
   1. American-Flow Control Series 500
   2. Clow Valve Company Model 2640
   3. Kennedy Valve Company Model Ken Seal II
   4. M&H Valve Company Model 4067
   5. Mueller Company Model 2360 Series Gate Valve
   6. United States Pipe and Foundry A-USPO

2.13 REDUCED PRESSURE BACKFLOW PREVENTER

A. The reduced pressure backflow preventer, with two independently operated check valves, shall be designed for installation in a normal horizontal flow attitude. An independent relief valve shall be located between the two check valves. They shall be in compliance with AWWA C511, certified to NSF/ANSI 61, and be as approved by any local authority having jurisdiction. The checks and the relief valve shall be accessible for maintenance without removed the device from the line. Provide full port gate valves with non-rising stems on both ends of assembly.

2.14 DUCKBILL CHECK VALVE

A. Check Valves are to be all rubber and the flow operated check type with a flanged end connection. The port area shall contour down to a duckbill which shall allow passage of flow in one direction while preventing reverse flow. The flange and flexible duckbill sleeve shall be one piece rubber construction with nylon reinforcement. The bill portion shall be thinner and more flexible than the valve body, and formed into a curve of 180°.

B. The flange drilling shall conform to ANSI B16.1 Class 125/ANSI B16.5, Class 150 standards. The valve shall be furnished with steel back-up rings for installation.
C. Manufacturer must have available flow test data from an accredited hydraulics laboratory to confirm pressure drop data. Company name, plant location, valve size and serial number shall be bonded to the check valve. Valves shall be manufactured in the USA.

D. When line pressure inside the valve exceeds the backpressure outside the valve by a certain amount, the line pressure forces the bills of the valve open, allow to pass. When backpressure exceeds the line pressure by at the same amount, the bills of the valve are forced closed.

E. Acceptable Manufacturers
   1. Tideflex Technologies Inc.
   2. EVR

2.15 DIAPHRAGM VALVES

A. All Diaphragm valves shall be Weir type constructed from PVC Type I, ASTM D 1784 Cell Classification 12454 or CPVC Type IV, ASTM D1784 Cell Classification 23447, or Polypropylene, ASTM D 4101 with union, socket, threaded, or flanged ends as required.

B. All diaphragms shall be EPDM. All valves shall have built-in position indicator with polypropylene handwheel. All True Union style valve union nuts shall have Buttress threads. All PVC and CPVC 1/2" through 2" valves shall be pressure rated to 235 psi, all 2-1/2" through 4" and all angled valves shall be pressure rated to 150 psi, all 6" valves shall be pressure rated to 100 psi, and all 8" valves shall be pressure rated to 75 psi for water at 73°F.

C. Acceptable Manufacturers
   1. Spears
   2. Hayward

2.16 BUTTERFLY VALVES FOR INTERIOR AND/OR EXPOSED SERVICE

A. All standard butterfly valves shall have materials of construction described as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Cast Iron</td>
<td>ASTM A126</td>
</tr>
<tr>
<td></td>
<td>or Ductile Iron</td>
<td>ASTM 536</td>
</tr>
<tr>
<td>Disc</td>
<td>Ductile Iron</td>
<td>ASTM A536</td>
</tr>
<tr>
<td>Shafts</td>
<td>Stainless Steel</td>
<td>ASTM 304</td>
</tr>
<tr>
<td>Packing</td>
<td>EPDM</td>
<td>---</td>
</tr>
<tr>
<td>Seat</td>
<td>BUNA-N</td>
<td>AWWA C504</td>
</tr>
<tr>
<td>Disc Edge</td>
<td>Stainless Steel</td>
<td>ASTM 316</td>
</tr>
<tr>
<td>Seat Ring</td>
<td>Stainless Steel</td>
<td>ASTM 316</td>
</tr>
</tbody>
</table>

B. Butterfly valves shall be of the rubber seat, tight-closing-type, Class as designated. Except as otherwise modified or supplemented herein, AWWA C504 shall govern the design, component materials, construction, manufacture, and testing of all butterfly valves.

C. The valves shall be of short body-type. Laying lengths for flanged-end butterfly valves shall be as specified in Table 2 of AWWA C504.
D. Valves shall be of such design that the valve discs will not vibrate or flutter when operated in a throttled position. Valve discs shall be secured to the shafts by means of keys or pins so arranged that the valve discs can be readily removed without damage thereto. All keys and pins used in securing valve discs to shafts shall be stainless steel or monel. Valve discs shall have no external ribs transverse to the flow direction. Valve discs of all sizes shall provide a tight shutoff at full differential pressures across the closed valve. The valve disc design shall provide a full 360 degrees seating surface uninterrupted by the shaft holes. The valve disc shall rotate 90o degrees from full-open to the tight-shut position.

E. All shafts shall be turned, ground, and polished. Shaft diameters shall meet minimum requirements specified in Table 3 of AWWA C504 for their class. The ends of the shaft shall be permanently marked to indicate the position of the valve disc on the shaft. Valves shall have solid one-piece shaft. Shaft bushings shall be contained in the integral hubs of the valve body and shall be of the "self-lubricated sleeve" type. A shaft seal shall be provided where the valve shaft projects through the body for the actuator connection. The seal shall be of the type utilizing a stuffing box and pull down packing gland so that the packing can be adjusted or completely replaced without disturbing any part of the valve or actuator assembly except the packing gland follower. Packing shall be self-adjusting split-V type or square type.

F. Valves shall be fitted with sleeve-type bearing. Bearings shall be corrosion resistant and self-lubricating. Bearing load shall not exceed one-fifth of the compressive strength of the bearing or shaft materials. Thrust bearing shall be designed to hold the disc in the center of the valve seat. The outboard thrust bearing shall be utilized to protect the shaft seal from thrust in the actuator.

G. Valve seat shall provide tight shut-off at the pressure specified in the valve schedule. Seats shall be incorporated in the valve body only. Seats shall be mechanically retained by means of stainless steel clamps, stainless steel rings, and 18-8 stainless steel bolts. Resilient seats must be capable of mechanical adjustment in each direction without the use of special tools. Seats must also be capable of replacement in the field without chipping, grinding, or burning out of the old seat. The mating seat surface shall be integral with the valve body or contained on the disc edge. Sprayed or plated mating seat surfaces are not acceptable.

H. The Manufacturer of butterfly valve for exposed or interior service shall be one of the following. Valves from other Manufacturers will not be accepted.

1. M&H.
2. K-Flo.
3. Valmatic.
4. DeZurik.
5. Henry Pratt.

2.17 SHOP PAINTING

A. Surface preparation and shop painting shall be as specified in Division 09.
PART 3 EXECUTION

3.01 INSTALLATION GENERAL

A. Items shall be installed per Manufacturer's instructions in the locations shown. Any damage to items shall be repaired to the satisfaction of the Engineer before they are installed.

B. Install brackets, extension rods, guides, the various types of operators and appurtenances as shown the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, check Drawings, which have a direct bearing on their location and be responsible for the proper location of these appurtenances during the construction of structures.

C. Items shall be carefully inspected for defects in construction and materials; debris and foreign material cleaned out of openings, etc.; operating mechanisms operated to check their proper functioning, and nuts and bolts checked for tightness. Equipment, which does not operate easily, or is otherwise defective, shall be repaired or replaced at no additional cost to the Owner.

D. Where installation is covered by a referenced Standard Specification, installation shall be in accordance with that Specification, except as herein modified.

E. Unless otherwise noted, joints for items shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint.

3.02 FIELD PAINTING

A. Field painting is specified in Division 9. Buried metal items or these in vaults or not otherwise coated shall receive two coats of bitumastic paint.

END OF SECTION
SECTION 40 05 57
VALVE APPURTEINANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and supply valve appurtenances as shown on the Drawings and as specified herein.

B. The equipment shall include, but not be limited to, the following:
   1. Manual valve actuators
   2. Electrical actuators and appurtenances
   3. Accessories

1.02 RELATED WORK

A. Division 09 – Finishes

B. Division 40 – Process Interconnections

1.03 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Manufacturer’s literature, illustrations, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.
   2. Submittal data for each valve, operator, and actuator.
   3. Deviations from the Contract Documents.
   4. Engineering data including dimensions, materials, size and weight.
   5. Fabrication, assembly, installation and wiring diagrams.
   6. Submit the following information for electric operators:
      a. Utilization voltage and number of phases
      b. Maximum current
      c. Horsepower
      d. Time to close
      e. Wiring diagram
      f. Type of gearing and lubrication
      g. Type of declutching mechanism
      h. Torque delivered to valve shaft
      i. Make and model
   7. Submit the following information for geared operators:
      a. Type of gearing
      b. Type of lubrication
      c. Size of handwheel, lever or crank
      d. Input torque required to develop required output torque
   8. If catalog bulletins are used to communicate above information, mark out inapplicable information.
B. Operation and Maintenance Data: Submit manufacturer's operating and maintenance instructions for equipment furnished under this Section.

C. Shop Tests:
1. Test motor operated valves before shipment to ensure that the mechanisms can close the valves in the specified time limit, and for proper seating.
2. Hydrostatic tests shall be performed, when required by the valve specifications included herein.

D. Certificates
1. Each actuator shall be performance tested and individual test certificates shall be supplied. The test equipment should simulate each typical valve load and the following parameters should be recorded:
   a. Current at maximum torque setting
   b. Torque at maximum torque setting
   c. Flash Test Voltage
   d. Actuator Output Speed or Operating Time
2. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.
3. Letter conforming coordination with valve and actuator supplier.
4. Each actuator configuration and setup shall be verified. Each actuator shall include documentation for all internal configurable settings and options. Data to include, but not limited to:
   a. Serial numbers for all circuit boards
   b. Direction of Close operation
   c. Open/Close action (limit or torque)
   d. Open/Close torque settings
   e. Limit contact configuration
   f. Any and all option configuration

1.04 REFERENCE STANDARDS


1.05 DESCRIPTION OF SYSTEMS

A. All equipment and materials specified herein are intended to be standard for use in controlling the flow of water.

B. The Water and Wastewater Equipment General Provisions (Section 46 00 00) shall apply to all equipment furnished under this Section.

C. The manufacturer of the equipment specified herein shall be required to review and satisfy all relevant requirements of other Sections of the Contract Documents and the requirements of the Contract Drawings. The Contract, manufacturer, supplier, fabricator and/or subcontractors furnishing and/or installing equipment, services and specialties associated with this Section shall fully coordinate their efforts to avoid potential claims that are based on failure to review relevant Contract Documents, including the Contract Drawings.
D. All of the valves actuators specified herein are intended to be specifically designed for use in controlling and/or isolating the wastewater flow stream as noted on the Drawings. Valve actuators and appurtenances shall be installed as shown on the Drawings and as specified, so as to form complete workable systems.

E. System Responsibilities:
   1. Valve Actuator Supplier responsibilities include sizing the actuators based on information provided by the manufacture of the valve. Providing the actuator and gear boxes where applicable, floor stands and stem extensions per application. All mounting fasteners, such as nuts, bolts and anchors shall be provided with floor stands to the Contractor. Gear boxes for butterfly valves shall be provided by actuator supplier for factory mounting and testing purposes.
   2. Valve Supplier responsibilities include providing torque requirements and coordinating dimensional requirements to the actuator supplier. Actuator supplier shall be responsible for factory mounting the gearbox and testing the valve. If desired by the Valve Supplier, Actuator Supplier shall furnish actuators and mounting hardware to the Valve Supplier for mounting prior to factory testing.
   3. Installation Contractor responsibilities include storing the actuators and valves once they are received in the field. The Contractor shall be responsible for mounting and aligning all the hardware in the field to provide a working system per specifications. The Contractor shall also coordinate the start up of each unit as applicable.

1.06 QUALITY ASSURANCE

   A. Equipment listed herein shall be products of manufacturers who have a minimum of five years experience in the manufacture of the particular equipment item to be furnished and show evidence of satisfactory service in at least five installations.

   B. Equipment of the same type shall be identical, varying only in size and product of one manufacturer.

1.07 TOOLS

   A. Special tools, if required for normal operation and maintenance, shall be supplied with the equipment.

1.08 DELIVERY, HANDLING, AND STORAGE

   A. The equipment manufacturer shall provide unloading, storage, and handling instructions prior to shipment.

   B. Equipment shall be protected against moisture. Temporary energize the space heaters during transport if required.

   C. All equipment shall be delivered in good sound condition, and free from damage. Equipment, which has been damaged, will be rejected.

   D. Store operators and electronic positioners indoors. Connect and operate space heaters, if recommended by manufacturer.
PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General:
1. All valve appurtenances shall be the size shown on the Drawings.
2. All valves and appurtenances shall have the name of the manufacturer, flow directional arrows, and working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
3. Except as otherwise shown on the Drawings or specified herein, all valves with operators whose centerline is located 6 feet or more above the operating floor shall be provided with chain wheel operators complete with chain guides and galvanized steel chain.
4. All buried valves shall open left (counter clockwise). Insofar as possible, all valves shall open counter clockwise.
5. Buried valves and operators, and those located in pump station, partially buried or within maximum of two feet above liquid, or in vaults, or where noted, shall be especially designed to completely submerge the valve and operator.
6. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to.
7. Buried valves shall be provided with adjustable two piece valve boxes and provided with extension stems, operating nuts and covers unless otherwise shown or specified. Extension stems shall terminate 12 inches below finished grade.
8. All bolts, nuts and studs on or required to connect buried, in vaults or submerged valves shall be Type 316 stainless steel.
9. All bolts and studs embedded in concrete and studs required for wall pipe shall be of stainless steel, Type 316.
10. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 193 Type 316 stainless steel.
11. Bolts and nuts shall have hexagon heads and nuts.
12. Gasket material and installation shall conform to manufacturer's recommendations.
13. Identification: Identify each valve 4 inches and larger with a brass or stainless steel nameplate stamped with the approved designation. Nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.

B. Valve Operator General Provisions:
1. Furnish geared operators with the following features, unless otherwise specified:
   a. Weatherproof enclosure
   b. Grease lubricated design
   c. Closes when turned clockwise
2. Paint operators as specified for valves.

2.02 MANUAL VALVE ACTUATORS

A. All manual valve actuators shall conform to AWWA C504.

B. Manual valve actuator shall be equipped with a totally enclosed worm gearing. Gears shall be permanently lubricated.
C. Manual valve actuators shall have a position indicator.

2.03 ELECTRICAL ACTUATORS AND APPURtenANCES

A. Acceptable Manufacturers
   1. Rotork Controls, Ltd. or Engineer approved equal.

B. General Requirements for All Electrical Actuators
   1. The actuators shall be suitable for use on a nominal 480-volt, 3 phase, 60 Hertz power supply and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.
   2. Time to open or close the valves/slide gates shall be two minutes unless noted otherwise.
   3. Integral Controls and Selector
      a. Integral to the actuator shall be local controls for Open, Close, and Stop, and an local/remote selector switch padlockable in any one of the following three positions:
         (i) Local Control only
         (ii) Off (No Electrical Operation)
         (iii) Remote Control plus Local Only
      b. The local controls shall be arranged so that the direction of travel can be reversed without the necessity of stopping the actuator.
      c. It shall be possible to select maintained or non-maintained local control without exposing the electronics to the environment.
   4. Actuator Sizing: The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.
   5. Ambient Temperature: The actuator shall be capable of functioning in an ambient temperature ranging from minus -22°F (-30°C) to +160°F (+70°C).
   6. Motor:
      a. The electric motor shall be Class F for open/close and Class H for process modulation with a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stoking time, whichever is longer, at an average load of at least 33% of maximum valve torque.
   7. Motor Protection:
      a. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits.
      b. Torque protection reset shall not allow repeated starting in the same direction when control signal is maintained.
      c. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator.
   8. Gearing:
      a. The design should be such as to permit the gearcase to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.
      b. The actuator gearing shall be totally enclosed in oil filled gearcase to permit the actuator to be mounted and operated in any position.
      c. Standard gear oil shall be used to lubricate the gearcase. Special or exotic lubricants shall not be used.
d. The drive shall incorporate a lost motion hammerblow feature to unseat a jammed valve.

e. All main drive gearing must be of metal construction.

f. The combined gear ratio shall ensure “self locking” characteristics at all times and shall be sufficient high ratio as to inhibit “backdriving” the actuator.

9. Hand Operation:
   a. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means.

   b. The drive being restored to power automatically by starting the motor. The hand/auto selection lever should be padlockable in both "Hand" and "Auto" positions.

   c. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.

   d. The handwheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time.

   e. A clockwise rotation of the handwheel shall provide a clockwise rotation of the output drive sleeve.

   f. Each actuator shall be capable of manual operation through the hand-wheel either by turning the 18” diameter hand-wheel or by connection to a power drill using a 2” socket.

10. Drive Bushing:
   a. The actuator shall be furnished with a machined drive bushing to suit the valve stem or shaft. Thrust bearings, when required shall be housed in a separate thrust base and be a sealed-for-life design.

11. Torque Sensing and Position Limits: Torque and turns limitations to be adjustable as follows:
   a. Torque setting: 40 to 100 percent of the rated torque

   b. Position setting range: 0.5 to 100,000 turns - with resolution not to exceed 15 degrees of one actuator center column revolution.

   c. For security purposes, all adjustments to torque and limit settings shall be limited to a removable intrinsically safe setting tool.

   d. “Latching” to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid-travel against high inertia loads.

   e. The electric circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.

12. Valve Position/Actuator Status Indication:
   a. In the event of a (main) power (supply) loss or failure, the position contacts must continue to be able to supply remote position feedback and maintain interlock capabilities.

   b. Eight (8) contacts shall be provided which can be selected to indicate any position of the valve with each contact selectable as normally open or normally closed. The contacts shall be rated at 5A, 250VAC, and 30VDC.

   c. As an alternative to providing valve position, any of the eight (8) contacts shall be selectable to signal one (1) of the following:

   d. Valve Opening or Closing
(i) Valve Moving (Continuous or Pulsing)
(ii) Motor Tripped on Torque in Mid-Travel
(iii) Motor Stalled
(iv) Actuator Being Operated by Handwheel
(v) Low Battery Charge

e. Configuration of actuator shall be done non-intrusively to prevent exposure to the local environment.

13. Local Position Indication:

a. The actuator shall include a digital position indicator to display the position of the valve as a percent open. The position shall be displayed even when the power to the actuator is isolated or turned off.
b. The local display should be large enough to be viewed from a distance of six feet (6') when the actuator is powered up.
c. Integral green, yellow and red LED's shall be provided that corresponds to the closed, intermediate and open position.
d. The local display shall include indicators for
(i) Torque overload
(ii) Loss of remote control
(iii) Loss of battery voltage
(iv) Failure of actuator

14. Integral Starter and Transformer:

a. The reversing starter, control transformer, and local controls shall be integral with the valve actuator suitably housed to prevent breathing and condensation buildup.
b. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of approximately 300 ms.
c. For on/off service, the starter shall be suitable for 60 starts per hour and of rating appropriate to motor size.
d. For process modulation, the starter shall be solid state and suitable for up to a maximum of 1,200 starts per hour and shall provide better than .25% accuracy.
e. The control transformer shall have the necessary tappings and be adequately rated to provide power for the following
(i) 120 VAC energization of the contactor coils.
(ii) 24 VDC output where required for remote controls
(iii) Fed all internal circuits.
(iv) Fuses shall protect the primary and secondary windings.

15. Remote Control Facilities:

a. The necessary wiring and terminals shall be provided in the actuator for the following control functions:
(i) Removable links or contact points for external interlocks to inhibit valve opening and/or closing.
(ii) Connections for external remote controls fed from an internal 24V DC supply and/or from an external supply of (min. 12V, max. 120V) to be suitable for any one or more of the following methods of control:
   (a) Open, Close, and Stop
   (b) Open and Close
(c) Overriding Emergency, Shutdown to Close (or Open) Valve from a “Make Contact.”

(iii) For process modulation the actuator shall incorporate a proportional controller that responds to a 4-20mA analog signal to position the valve remotely and include a transmitter to provide a 4-20mA analog output signal corresponding to valve position if required by control drawings. Any positioners or position transmitters shall be contactless.

(iv) The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of approximately 300 ms.

(v) The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2.5 kV.

16. Monitoring and Diagnostic Facilities:
   a. A total of (2) non-intrusive PDA’s, capable of IrDA communication for uploading and downloading all variables for the actuator as well as performing detailed diagnostics shall be provided and supplied by the valve actuator manufacturer.
   b. A diagnostic module, which will store and enable the download of historical actuator data to permit analysis of changes in actuator or valve performance, shall be included.
   c. It shall be possible to examine at a minimum
      (i) Average torque value in open and closed direction
      (ii) High torque value and it occurrence in open and closed direction
      (iii) Local control operation with time and date
      (iv) Actuator inhibits with time and date
   d. Diagnostic status screens must be provided to show multiple functions simultaneously so that troubleshooting can be affected rapidly and efficiently. All diagnostic information should be contained on no more then seven (7) or eight (8) screens so that multiple functions can be checked simultaneously.
   e. Duplex communication must be possible to facilitate downloading actuator setup, adjusting or diagnosing via a computer running Microsoft Internet Explorer 4+ and a standard IrDA interface.

17. Wiring and Terminals:
   a. Internal wiring shall be of tropical grade PVC insulated stranded cable of appropriate size for the control and the power supply. Each wire shall be clearly identified at each end.
   b. The terminals shall be embedded in a terminal block of high tracking resistance compound.
   c. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal.
   d. The terminal compartment of the actuator shall be provided with at least three (3) threaded cable entries.
   e. All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.
   f. A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:
      (i) Serial Number
(ii) External Voltage Values
(iii) Wiring Diagram Number
(iv) Terminal Layout
   This card must be suitable for the contractor to inscribe cable core identification beside terminal numbers.

18. Enclosure:
a. Actuators shall be 'O' ring sealed, watertight to NEMA 6/IP 68 at 7 meters of water for 72 hours.
b. Enclosure must allow for site storage without the need for electrical supply connection.
c. All fasteners shall be stainless steel.

19. Factory inspection, testing and deficiency correction shall be performed in accordance with the referenced applicable Standards. The electric motor operators shall be provided with a certified factory test report that will indicate date of manufacture, torque testing utilized, locked rotor amps output torque and wiring diagram.

2.04 ACCESSORIES

A. Furnish accessories specified or required for a complete permanent, operable system.

B. Floor boxes to have cast iron bodies and bronze bushings.

C. Valve boxes and concrete manhole for buried service will be furnished and installed by the Contractor.

D. Chain wheels:
   1. Chain guides
   2. Rustproof

E. All exposed valves 8 inches and larger shall have 10-inch minimum diameter handwheel operators, unless other types of operators are required.

F. Acceptable Manufacturers:
   1. Floor boxes: Clow, Model F-5695 or equal.
   2. Chain Wheels: Clow, Model F-5680 or equal.

2.05 SHOP COATING

A. Valves and appurtenances shall be shop coated in accordance with Division 09.

B. External surfaces of all buried valves and accessories shall be shop coated with two coats of coal tar epoxy to produce a total DFT of 16 to 20 mils.

C. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

D. Contractor shall be responsible for field touch-up of painting.
PART 3  EXECUTION

3.01  INSTALLATION

A. All valves and appurtenances shall be installed by the Contractor in the locations shown, true to alignment and rigidly supported.

B. After installation, all valves and appurtenances shall be tested at the same duration and pressure as the piping system they are in.

C. Buried valve and valve boxes shall be set with the stem vertically aligned in the center of valve box. Valves shall be set on a firm foundation and supported by tamping excavated material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade.

D. All valves actuators shall be installed per the Manufacturer’s published instructions in the locations shown, true to alignment and rigidly supported. Any damage to the valves and appurtenances shall be repaired to the satisfaction of the Owner and Engineer prior to acceptance.

E. Install all brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings, or otherwise required. Before setting these items, the Contractor shall check all Drawings and Specifications which have a direct bearing on their location. The Contractor shall be responsible for ascertaining the proper location of all valves actuators prior to their installation.

F. All valves actuators shall be carefully inspected for defects. All debris and foreign material shall be cleaned out of openings, etc. All valve flange covers shall remain in place until connected piping is in place. All operating mechanisms shall be exercised to check for proper operation and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.

G. All valves and other items shall be installed in the proper position as recommended by the Manufacturer. The Contractor shall be responsible for verifying the Manufacturers’ torque requirements for all valves.

H. Unless otherwise noted, all valve operators shall be installed as specified herein so as to allow access to operate and maintain components and to prevent interference with other piping, valves and appurtenances.

3.02  ASSEMBLY OF ACTUATORS TO NEW VALVES

A. For all valves having direct-mounted actuators, except those furnished with extension shafts, torque tubes, or floorstands, the valve and actuator shall be assembled and performance tested in accordance with Section 5.3 of AWWA C542.

3.03  ACTUATOR/CONTROLS START-UP PERSONNEL

A. The Supplier of the valve actuators and related controls shall provide a factory-trained technician to supervise, calibration, and start-up as required. On completion of start-up, a certificate of installation shall be provided by the valve actuator supplier indicating proper
installation and start-up procedures have been followed. This document certifying the installation shall be included as part of the final operation and maintenance manuals. The Supplier of valve actuators and related controls shall provide a factory-trained technician for operation and maintenance training of Owner's personnel.

3.04 INSPECTION AND TESTING

A. The valves and appurtenances and the various pipelines in which these are to be installed shall be field tested by the Contractor. During these tests any defective valve or appurtenance shall be adjusted, removed and replaced, or otherwise made acceptable to the Owner by the Contractor.

B. Various regulating valves, or other appurtenances, shall be tested by Contractor to demonstrate their conformance with the specified operational capabilities and any deficiencies. Any deficiency shall be corrected or the device replaced or otherwise made acceptable to the Owner.

C. The Contractor shall take care not to over pressure valves or actuators during pipe testing. If any valve or actuators proves to be defective, it shall be replaced or repaired to the satisfaction of the Engineer.

D. No testing shall be performed until both the valve manufacturer's and Valve Actuator Manufacturer's service engineer has provided written certification that the installed equipment has been examined and found to be in complete conformance with the valve and valve actuator manufacturers requirements.

E. Functional Testing - Prior to startup, all valve actuators shall be inspected by the valve actuator service engineer for proper alignment, proper operation, and satisfactory performance. All valves actuators shall be tested for proper function and operation under actual field conditions for at least four hours, without vibration, jamming, leakage, or overheating, and shall satisfactorily perform as specified and in accordance with their published performance capabilities.

F. The various pipe lines in which the valves and appurtenances are to be installed are specified to be field tested. During these tests, any defective valve actuators shall be adjusted, removed and replaced, or otherwise made acceptable to the Engineer.

G. All items (including valve interiors) shall be cleaned prior to installation, testing, disinfection and final acceptance.

END OF SECTION
SECTION 40 05 97
IDENTIFICATION FOR PROCESS EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Related Work Specified Elsewhere:
   1. Shop Drawings, Product Data and Submittals.
   2. Painting: Division 9.

B. Scope: The work included in this Section of the specifications consists of the identification of all piping systems, valves and equipment, as well as the installation of hazards, safety and operation signs by the Contractor.

PART 2 PRODUCTS

2.01 PIPING IDENTIFICATION

A. General: All exposed piping shall be painted per the color code listed in Section 2.01, E.2. The entire pipe shall be painted. All exposed piping, unless specified otherwise, shall have a product identification label painted on the piping. Where pipes are too small for such application, a brass identification tag shall be fastened securely at specified locations. Tags will be a minimum 1-1/2-inch in diameter with depressed black figures of appropriate size.

B. Identification Label: The label shall consist of a minimum of two coats of paint, with the surface preparation, materials and application of paint conforming to the requirements of Painting, Division 09 of the Specifications.

C. Location: Labels shall be applied to the piping at locations as follows:
   1. Each branch and riser at take-off.
   2. At each pipe passage through wall, floor and ceiling construction.
   3. At each pipe passage to underground.
   4. At not more than 5 feet spacing on straight pipe runs.
   5. At each valve, strainer and all pieces of equipment.

D. Letter Size: The letter sizes corresponding to the applicable outside diameter of pipe or pipe covering shall be used. Upper case letters and Arabic Numerals shall be used. Sizes are as follows:

<table>
<thead>
<tr>
<th>Outside Diameter of Piping Covering</th>
<th>Width of Color Band or Block</th>
<th>Size of Legend Letters and Numerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; to 1-1/4&quot;</td>
<td>8&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>1-1/2&quot; to 2&quot;</td>
<td>8&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; to 6&quot;</td>
<td>12&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>8&quot; to 10&quot;</td>
<td>24&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>Over 10&quot;</td>
<td>32&quot;</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>
E. Labels shall be placed so as to be easily read from operating positions. Adjacent to label, arrows will indicate the direction of flow of material under normal operating conditions.

1. The legend color shall be either white or black, providing it is a contrast to the color of the band or pipe, except as noted below.

2. The band or block color and product will include but not be limited to the following:

<table>
<thead>
<tr>
<th>Product/Legend</th>
<th>Color of Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable Water</td>
<td>Light Blue</td>
</tr>
<tr>
<td>Compressed Air</td>
<td>Light Green</td>
</tr>
<tr>
<td>Instrument Air</td>
<td>Light Green with Dark Green Bands</td>
</tr>
<tr>
<td>Non Potable Water</td>
<td>White</td>
</tr>
<tr>
<td>Raw Water</td>
<td>Tan</td>
</tr>
<tr>
<td>Wastewater/Sewage Line</td>
<td>Grey</td>
</tr>
<tr>
<td>Sludge Line</td>
<td>Brown</td>
</tr>
<tr>
<td>Sodium Hypochlorite</td>
<td>Yellow with Red Bands</td>
</tr>
</tbody>
</table>

3. The Owner shall select the final colors during the submittal process. Any identification made prior to Owner selection shall be at the Contractors expense.

2.02 EQUIPMENT IDENTIFICATION

A. Titles shall be provided on all equipment, including pumps and blowers using 1-in high Helvetica Medium upper case, Grid 2 spacing, white in color except as otherwise noted on the drawings or in these specifications. Titles shall include both the equipment number and name, as indicated in the equipment schedule as shown in the Drawings, or as otherwise indicated by the Engineer. Titles shall be mounted at eye level on machines where possible, or at the upper most board vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, the items shall be numbered consecutively as indicated on the mechanical drawings or as directed by the Consulting Engineer; for example Pump No. 1, Pump No. 2, etc.

B. Titles shall be sized, proportioned, arranged and located to be easily readable. It may be required by the Consulting Engineer that some equipment be labeled in two or more places, in which cases, the Contractor shall comply with no additional cost to the Owner. All submersible pumps shall be labeled twice: once on the pump itself, and once on the concrete or metal plate at the top of the pump's guide pipes.

C. The Contractor shall submit for Consulting Engineer's approval, in accordance with Division 1, a listing of all equipment titles he proposes to provide, including for each equipment's labeling:

1. Size and color of letters to be used.
2. Location(s) of labels.
3. Formation of label
4. Equipment titles shall match the process flow diagrams included in the Contract Drawings.

D. It is the intent of these specifications that all equipment items be labeled and that such labeling allows easy identification of the item of equipment from the direction(s) from it will most normally be viewed.

2.03 HAZARD IDENTIFICATION AND WARNING

A. All physical hazards within the scope of this Project shall be identified by signs or markings as required by OSHA and described in the Federal Register, Volume 37, No. 202, under Paragraph

B. Signs, tags, tapes and other materials used for this purpose shall be of as good or better quality and durability as those manufactured by W.H. Brady Company, Milwaukee, Wisconsin, or Seton Name Plate Corporation, New Haven, Connecticut or approved equal.

C. Type or Class of Service:
1. For attachment to smooth metal, painted or enameled surfaces, use self-sticking vinyl, as Brady B-940, Seton or approved equal. This may also be used for message section on standard warning or directional signs.
2. For attachment to rougher, porous surfaces, such as concrete or wood structures, chain link fencing, etc., use self-supporting fiberglass, as Brady B-60, Seton or approved equal. When affixing to curved object such as rough pipe or pole, use polyethylene such as Brady B-450, Seton or approved equal.

D. Minimum Dimensions: Accident prevention signs shall be of OSHA standard dimensions, of the sizes called for in Paragraph 2.05, Sign Schedules. Dimensions are in inches, for horizontal pattern, height by width. For upright pattern, reverse the dimensions.

E. Colors: Colors of signs, symbols and lettering shall comply with the requirements of OSHA 1910.145.

2.04 SIGNS

A. General: Classification of accident prevention signs and tags (per OSHA):
1. Danger Signs. White letters or a red oval surrounded by rectangular black field in combination with specific message sections as called for in Paragraph 2.05, Sign Schedules.
2. Caution Signs. Yellow letters on a black field in combination with specific message sections called for in Paragraph 2.05, Sign Schedules.
3. Safety and Other Instructional Signs. The colors and design of instructional signs shall be red block capital letters on white background, with text and sizes as indicated in Paragraph 2.05, Sign Schedules.
4. NFPA Placard. NFPA Diamond in combination with specific message sections (left diamond, top, right, and bottom) as call for in Paragraph 2.05, Sign Schedules.

2.05 SIGN SCHEDULES

A. "Danger Signs":
1. Description:

<table>
<thead>
<tr>
<th>Item</th>
<th>Specific Message Section</th>
<th>Size-Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-1</td>
<td>High Voltage</td>
<td>7 x 10</td>
</tr>
<tr>
<td>D-2</td>
<td>High Voltage</td>
<td>10 x 14</td>
</tr>
<tr>
<td>D-3</td>
<td>Hazardous Area No Smoking</td>
<td>10 x 14</td>
</tr>
<tr>
<td>D-4</td>
<td>Danger – Permit Required, Confined Space, Do Not Enter</td>
<td>6 x 18</td>
</tr>
</tbody>
</table>

2. Location Schedule:

<table>
<thead>
<tr>
<th>Item</th>
<th>Location</th>
</tr>
</thead>
</table>

40 05 97 - 3 APRIL 2019 IDENTIFICATION FOR PROCESS EQUIPMENT
D-1 On outside door of motor control centers, distribution panels and switchgear.
D-2 Adjacent to transformers.
D-4 All structures considered Confined Space

B. “Caution” Signs:
1. Description:
<table>
<thead>
<tr>
<th>Item</th>
<th>Specific Message Section</th>
<th>Size-_inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>Non-Potable Water Do Not Drink (w/ Spanish Translation)</td>
<td>6x18</td>
</tr>
</tbody>
</table>

2. Location Schedule
<table>
<thead>
<tr>
<th>Item</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>Adjacent to Hose Stations</td>
</tr>
</tbody>
</table>

C. NFPA Placard:
1. Description:
<table>
<thead>
<tr>
<th>Item</th>
<th>Specific Message Section</th>
<th>Size-_inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-1</td>
<td>“2”, “0”, “0”, N/A</td>
<td>16x16</td>
</tr>
</tbody>
</table>

2. Location Schedule:
<table>
<thead>
<tr>
<th>Item</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-1</td>
<td>At Sodium Hypochlorite Building</td>
</tr>
</tbody>
</table>

PART 3 EXECUTION

3.01 INSTALLATION

A. The installation of identification for pipes, equipment, and signs shall be as specified above.

END OF SECTION
SECTION 40 41 13
PROCESS PIPING INSULATION AND HEAT TRACING

PART 1 GENERAL

1.01 SCOPE OF WORK
A. The work to be performed under this section of the specifications consists of furnishing and installing insulation on piping and equipment as required by this section of the specifications, unless otherwise indicated.

1.02 SUBMITTALS
A. Product Data and Shop Drawings. Submit product data and shop drawings on insulation, heat tracing materials, etc., in accordance with Division 01 - General Requirements.

1.03 REFERENCE STANDARDS
A. The system shall be suitable for the specified industrial conditions, and shall be designed and installed in accordance with the latest applicable codes and standards. Pertinent standards are:
   1. American National Standards Institute (ANSI)
   2. Institute of Electrical and Electronics Engineers (IEEE)
   3. American Society for Testing and Materials (ASTM)
   4. National Fire Protection Association (NFPA)
   5. National Electric Code (NEC)
   6. Factory Mutual (FM)
   7. Underwriters Laboratories (UL)
   8. National Electrical Manufacturers Association (NEMA)
   9. Occupational Safety and Health Administration (OSHA)
B. Furnish copies of the necessary approvals for the heat tracing system and verify that the approvals are current.
C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 GENERAL
A. Engage the services of qualified insulation personnel to furnish and install all the insulation required for the piping specified hereinafter.
B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where coverings are used, they shall lap the adjoining section of insulation by at least 3 inches. Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe has been pressure tested and found tight. Piping flexible connections, flanges and unions shall not be covered. All materials used shall be fire retardant or nonflammable.
C. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation
with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

D. Aluminum bands shall be applied on the piping insulation. The bands shall be applied three to a section of pipe insulation. Fittings, valves, etc., shall have bands on each side. Apply bands at each end of pipe support.

E. Where supports are on the outside of the insulation, use a section of Foam glass or rigid cork insulation at support locations and provide No. 14 gage galvanized steel sleeves, 12 inches long on pipe sizes up to 12 inches and 18 inches long on larger pipe sizes to protect the insulation. The sleeves shall be half cylinders with the edges hemmed to prevent cutting the insulation.

F. All materials used shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion, and with a smoke developed rating not higher than 50. Shop drawing submittals shall show this information.

G. Weather exposed insulation shall be protected with 0.010 inches minimum aluminum jacket including vapor barrier liner of laminated asphalt Kraft paper.

2.02 FREEZE PROTECTION

A. Insulation:

1. Unless otherwise indicated in the specific requirements and/or on the plans, all piping, fittings, valves and related items smaller than 12 inches exposed outdoors in yard in an unheated space subject to freezing shall be heat traced and insulated.

2. Buried yard piping need not be insulated.

3. Piping capable of draining automatically need not be insulated.

4. All insulation of pipes shall run to a point 12 inches below ground surface.

B. Heat Tracing: Refer to Section 26 05 60.

C. Schedule: Unless otherwise specified or shown elsewhere in the contract documents, the following schedule of insulation and heat tape application shall be used:

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in)**</th>
<th>Insulation Thickness (in)</th>
<th>Insulation &quot;K&quot;*</th>
<th>Heat Tape Application Rate (Minimum) Watts/Linear Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>½</td>
<td>2</td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td>¾</td>
<td>2</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>1-1/2</td>
<td>2</td>
<td>0.3</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0.3</td>
<td>1.8</td>
</tr>
<tr>
<td>2-1/2</td>
<td>2</td>
<td>0.3</td>
<td>1.9</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>0.3</td>
<td>1.9</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>0.3</td>
<td>2.7</td>
</tr>
</tbody>
</table>
6  2  0.3  2.7
8  2  0.3  2.7
10 2  0.3  2.7
12 2  0.3  2.7

* "K" - Thermal conductivity of insulation in BTUH per square foot per degree Fahrenheit, per inch.

** Insulation and heat tape required for a pipe size not shown on the schedule shall be the same as the next larger pipe size shown on this schedule.

PART 3 EXECUTION

3.01 INSULATION

A. The insulation specified herein shall be furnished and installed by qualified insulation personnel whose principal business is the application and installation of thermal materials on piping systems. All material shall be manufactured by one of the listed approved manufacturer's instructions, except where these instructions conflict with the specifications hereinafter stated, in which case the specifications shall govern. All work shall be performed in a neat workmanlike manner and all adhesives, bands and other fastening materials and devices shall be supplied as required to properly install the insulation materials being furnished.

B. Acceptable Manufacturers:
1. Armstrong Co.
2. CertainTeed
3. Owens-Corning Fiberglass
4. Pittsburg Plate Glass Co.
5. Pittsburg – Corning

END OF SECTION
SECTION 43 25 60

CHEMICAL METERING PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required and install, test and place in satisfactory operation two (2) peristaltic chemical metering pumps for the sodium hypochlorite system equipped complete, as shown on the Drawings and as specified herein. Provide one (1) additional metering pump to the Owner as a spare, for a total of three (3) pumps. The work of this section includes, but is not limited to, providing two (2) skid-mounted peristaltic chemical metering pumps with accessories, including chemical tote, for the application of sodium hypochlorite for the potable water system. All necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in this section or not shall be furnished and installed as required for an installation incorporating the highest standards for this type of service.

B. The work requires that one Manufacturer accept responsibility for furnishing the equipment and work as indicated but without altering the Contractor’s responsibilities under the Contract Documents.

1.02 RELATED WORK

A. Drawings and all provisions of the Contract Documents shall apply to this Section.

B. General provisions included in Division 1.

C. Painting included in Division 9.

D. Electrical included in Division 26.

E. Process Interconnections in Division 40.

F. Water and Wastewater Equipment in Division 46.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with the Uniform General Conditions, shop drawings and product data. Submittals shall include, but not be limited to the following:

1. Certificate of Compliance or complete list of all deviations from the drawings and specifications.

2. Complete fabrication, assembly, and installation drawings, showing the Manufacturer’s dimensions, weights, and loadings, and descriptive information in sufficient detail to show the kind, size, weight, arrangements, operation, component materials and devices, external connections, anchorages and supports required, performance characteristics, and dimensions needed for installation.

3. Detailed specifications and data covering materials used, parts, instrumentation devices, and other accessories forming a part of the equipment furnished will be submitted for review.

4. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.
5. Manufacturer’s installation instruction and certification.
7. Manufacturer’s warranty agreement in compliance with the Contract Documents.
8. Electrical data including control wiring. Electrical/pneumatic requirements, schematic diagrams, and details of components including enclosures.
9. Complete motor and drive data.
10. Manufacturer’s recommended spare parts.
11. Certification factory certified Engineer or local Field Service Representative as required in Paragraph 1.07.
12. Installation, start-up, and test schedule with installation and test procedures shall be furnished prior to installation of the equipment.
13. The Manufacturer’s representative shall prepare a calibration graph from field tests for each metering pump. Graphs shall read in gallons per hour. The graph shall show the rate setter graduation conversion to gallons per hour throughout the range of the feed unit. Each graph shall be furnished on hard paper and be sealed in clear plastic.
14. Prepare shop drawings of the skid supports/anchoring under the seal of a Professional Structural Engineer licensed in the State of Texas. Certify installed skids with supports will safely support design loads.

B. All submittal requirements as specified in related sections shall apply to the work described in this section.

1.04 REFERENCE STANDARDS

A. Design, manufacture, and assembly of elements of the equipment herein specified shall be in accordance with, but not limited to published standards of the following as applicable:
1. American Gear Manufacturer’s Association (AGMA).
4. American Society of Mechanical Engineers (ASME).
8. Anti-Friction Bearing Manufacturer’s Association (AFBMA).
10. Institute of Electrical and Electronics Engineers (IEEE).
12. National Electrical Manufacturer’s Association (NEMA).
13. Occupational Safety and Health Administration (OSHA).
14. Steel Structures Painting Council (SSPC).
15. Underwriters’ Laboratories, Inc. (UL).
16. Factory Mutual (FM).

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
1.05 QUALITY ASSURANCE

A. The equipment specified herein is intended to be peristaltic chemical metering pumps of proven ability as manufactured by parties having extensive experience (at least five (5) installations of the same design, with a minimum of three years successful operation) in the production of such equipment. The peristaltic chemical metering pump shall be fabricated as an integral unit by a single Manufacturer. The equipment furnished shall be designed, constructed and installed to operate satisfactorily when installed as shown on the Drawings. Equipment furnished shall operate satisfactorily under all operating conditions including, but not limited to liquid levels in the tote/drum varying from full to within 1/2 inch off the bottom and the full range of discharge conditions.

B. If submitted equipment requires arrangement differing from that which is indicated on the drawings or specified, prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and embodying all special features of equipment proposed. Any changes are at no additional compensation and the Contractor will be responsible for all Engineering costs of redesign by the Engineer, if necessary.

C. Pumps shall be NSF certified.

D. Acceptable Manufacturers:
   1. Blue-White Industries, Ltd.
   3. Verder by GPM Pumps, Inc.
   4. Periflo, Inc.

1.06 SYSTEM DESCRIPTION

A. General:
   1. Peristaltic chemical metering pumps shall be skid mounted and shall be integrated equipment packages to automatically meter and feed chemicals. Pumps shall be of corrosion-resistant construction.
   2. Factory Testing:
      a. Each peristaltic chemical metering pump shall be fully assembled, and non-witness tested at the Manufacturer's own shop to ensure compliance with pressure and operational requirements. Any defects or problems shall be corrected prior to shipment. A certified report of compliance and any corrective actions shall be submitted to the Engineer.
      b. Functional Test: Perform Manufacturer's recommended functional testing, including standard tests, as follows:
         (i) Conduct performance testing on each pump and submit the total head, pressure, line amps, and speed of each pump unit.
         (ii) Complete performance testing at design flow and design pressure as specified.
         (iii) Submit all testing results and pump curves as specified.

B. Design Criteria: The peristaltic metering pump shall be designed to meter and feed sodium hypochlorite as specified herein. The application of sodium hypochlorite shall be based on the following design requirements:
   1. Location.................................................................................................. Sodium Hypochlorite Building
2. Number of Pumps (includes stand-by and spare) ........................................... 3
3. Equipment Number ...................................................................................... MP-001 and MP-002
4. Type of Chemical ......................................................................................... Sodium Hypochlorite (12.5% Concentration)
5. Type of Peristaltic Pump ............................................................................. Tube
6. Maximum Feedrate (gph) .............................................................................. 8.00
7. Minimum Feedrate (gph) ............................................................................. 0.5
8. Pressure at application point (psi) ................................................................. 50
9. Minimum Turndown ....................................................................................... 200:1
10. Drive ........................................................................................................... Variable Speed
11. Maximum Power .......................................................................................... 120 volt, single phase, 60 Hz
12. Duty ........................................................................................................... Continuous
13. Ambient Environment .................................................................................. Indoor/Corrosive

1.07 SERVICES OF MANUFACTURER’S REPRESENTATIVE

A. Operating and maintenance manuals shall be furnished to the Owner as provided in the Uniform General Conditions. The manuals shall be prepared specifically for this installation and shall include all required cut sheets, drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with the polymer activation units operation and maintenance. In addition to the requirements of the Uniform General Conditions, the manuals shall include the following at a minimum:
1. Complete parts list, cross-referenced to exploded view assembly drawings.
2. Step-by-step disassembly and reassembly instruction including tolerances and torque requirements.
3. Dimensional drawings for all provided components with their respective weights.
4. Annotated control panel and electrical equipment wiring diagrams.

B. Provide the services of a factory certified service Engineer specifically trained in the installation, start-up, testing, operation, and maintenance of the peristaltic chemical metering pumps as herein specified. Such services shall be provided by a representative who is a direct, full-time employee of the peristaltic chemical metering pump Manufacturer(s) or local representative certified by the Manufacturer in installation and startup of the equipment.

C. The peristaltic chemical metering pump factory certified Engineer shall advise, consult, and instruct the Contractor on installation procedures and adjustments and inspect the operators during installation as a condition of acceptance of the work.

D. The peristaltic chemical metering Pump Factory Certified Service Engineer shall again be present during all start-up and testing operations to make final adjustments as a condition of acceptance of the work.

E. Owner training shall be provided and shall include operational instructions to two separate operational teams over a minimum of two separate time periods. Training shall be given at times convenient to the operational team being trained in light of 12-hour operational shifts and duties while on shift. Accordingly, some operational training will have to be conducted during hours outside a normal Monday through Friday, 8:00am to 5:00pm, work day. Operational training shall include the following at a minimum:
1. Control and operation of all pumps and appurtenances.
2. Trouble shooting guidance.
3. Recognizing normal and abnormal operating conditions.

F. Owner training shall also include maintenance instructions to one maintenance team. Maintenance training shall be conducted during the hours of 9:00am to 3:00pm, Monday through Friday, with exact schedule being determined in light of on-going maintenance team duties. Maintenance training shall include the following, at a minimum:
   1. Step-by-step assembly and disassembly procedural requirements.
   2. Replacement part identification and ordering procedures.
   3. Lubrication procedures.
   4. Torque and limits switch adjustment.
   5. Recommended routine maintenance procedures.
   6. Trouble-shooting and diagnostic procedures.
   7. Fuse and pilot lamp replacement.

G. Person-hour requirements tabulated below are exclusive of travel time and do not relieve the Contractor of obligation to provide sufficient services to place all equipment and appurtenances into satisfactory operation.

<table>
<thead>
<tr>
<th>Services to be Provided by Factory Certified Service Engineer</th>
<th>Minimum Number of Trips</th>
<th>Minimum Time On-site Per Trip (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assist in the Installation of peristaltic chemical metering pumps.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2. Assist in the Start-up and Testing of peristaltic metering pumps &amp; Train Owner's Operations and Maintenance Personnel.</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

1.08 SPARE PARTS

A. All spare parts requirements as specified in related sections shall apply to the work described in this section.

B. Provide one spare chemical metering pump.

C. All tools and spare parts shall be properly packed and protected for long-term storage and placed in containers clearly identified in indelible marking as to content. Each part shall be sealed, wrapped, or otherwise protected from corrosion during storage. All tools shall be furnished in labeled steel toolboxes.

D. Provide spare parts for two years continuous operation that shall include at a minimum: one 16 ounce tube of food grade lubricants required by Manufacturer design per pump and four hoses/tubes per pump to meet the feedrate range.

1.09 DELIVERY, STORAGE AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment unit installation is completed and the equipment is ready for operation.
B. Equipment shall be handled and stored in accordance with the Manufacturer’s instructions. None of the components of the equipment shall be dropped and all the components shall be examined before installation. No items shall be installed which are found to be defective, and must be repaired to the satisfaction of the Engineer.

C. Factory assembled parts and components shall not be dismantled for shipment or storage unless recommended by the Manufacturer in writing to the Engineer.

D. The finished surfaces of all exposed flanges shall be protected by wooden or equivalent blank flanges, strongly built and securely bolted.

E. Finished iron or steel surfaces not factory painted shall be properly protected to prevent rust and corrosion.

F. No shipment shall be made until approved by the Engineer in writing.

1.10 WARRANTY

A. The equipment Manufacturer shall provide a one (1) year warranty, commencing on the date of Substantial Completion, for all parts associated with the equipment and the labor associated with repair and/or replacement of the parts. The warranty shall include normal wear and tear parts. All materials, equipment, and workmanship shall be free from defects in material or workmanship. The shop drawing shall include a contract specific warranty document as detailed in the Uniform General Conditions. Approval of the shop drawings will be contingent on the receipt of the warranty.

B. Manufacturer’s Certification: Provide a letter of certification addressed to the Owner and signed by an authorized representative of the Manufacturer. The letter shall state the following:

   1. The equipment will efficiently and thoroughly perform the required functions in accordance with the Contract Documents, that the materials are best suited for the chemicals handled, and that the Manufacturer accepts joint responsibility with the Contractor for coordination of equipment, including motors, controls, and services required for proper installation and operation of the completely assembled and installed unit.

   2. The equipment has been installed in accordance with the Manufacturer’s recommendations, and is in proper adjustment and operating condition, the Manufacturer is prepared to warrant the equipment to perform in full compliance with these specifications, and the equipment is ready to be turned over to the Owner for operation.

   3. The Manufacturer has inspected the installation and verified training of the Owner’s operations and maintenance personnel upon completion of the system installation.

PART 2 PRODUCTS

2.01 PERISTALTIC METERING PUMP

A. General: Pump components shall be constructed of corrosion resistant materials suitable for the chemical specified. Wetted parts of all metering pumps and appurtenances specified herein shall be confirmed by the Manufacturer to ensure optimum corrosion and erosion free operations for the chemicals involved. Manufacturer shall provide written certification that the equipment and materials have been selected for the chemicals being pumped.

B. Construction:
1. The pumps shall be of the simplex, motor-driven, peristaltic tube or hose type unless otherwise specified. Each pump shall consist of a sealed corrosion resistant housing with bolted or quick release cover, view port in the cover, and roller compressor mechanism designed for operation with either tube or hose. Tube/Hose shall be rigidly mounted to the pump body with NPT or Camlock connections. The pump assembly shall be three (3) components consisting of a standard pump head close-coupled to a commercial gearbox that is directly connected to a NEMA motor. Drive and controls shall be provided by the pump Manufacturer in the pump control panel.

2. Housing: Corrosion resistant material, as recommended by manufacturer. Housing shall be mounted in an orientation with the suction and discharge connections located as shown on the Drawings.

3. Rotor: Corrosion resistant material. Rotor shall mount directly on the keyed gearbox output shaft and shall be axially sealed and secured to the shaft.

4. Shafts: Corrosion resistant.

5. Rollers/Shoes: Two (2) or three (3) reinforced rollers for compression of the tube/hose against the housing. One roller shall at all times be fully engaged with tubing providing complete compression to prevent back flow or siphoning.

6. Roller/Bearings: One-piece Roller/Bearings are corrosion resistant, journal bearing design.

7. Cover: Removable one (1) piece clear corrosion resistant polycarbonate viewing cover sealed to the pump body with an Viton gasket or material compatible with chemical handled.

8. Connections: Rigid, pressure rated inlet and outlet connections shall be Camlock or Kynar, CPVC or 316SS material as required by the process. Loose tube-end connections to process are not acceptable.

9. Baseplate: Supporting base integral to pump shall be 316 SS or corrosion resistant material as approved by Engineer.

10. Assembly: Rotor and housing are bolted directly to the output flange of the gearbox, which serves to support the rotor and center the rotor assembly within the pump housing. Pump to gearbox connection shall be close coupled and self-aligning requiring no flexible couplings. Long-coupled pumps with external couplings are not acceptable.

11. Gearbox: Gearbox shall be integral to the pump.

12. Performance: Each pump shall be capable of self-priming when completely dry with a suction lift capability of up to 27 feet of water. The pump shall be capable of running dry without damaging effects to the pump or tube/hose. The pump shall use no check valves or diaphragms and not utilize any dynamic seals in contact with the fluid being pumped.

13. Speed: Pump operating speed shall be minimized per Manufacturer's recommendations in order to maximize tube/hose life.

C. Tubing: Thermoplastic tubing shall be designed specifically for use with peristaltic pumps and working pressures to the pump's rated pressure. They shall be constructed from the highest quality materials designed for operation with the chemical being pumped. Tubing lubrication shall be food-grade silicon grease as required per Manufacturer.

D. Connections:
   1. Provide PVC port connections as required by the application.
   2. Camlock, flanged or MNPT port connection size to be determined by model.

E. Motor:
   1. Case pumps shall have integral DC motors.
F. Leak Detector: Provide one sensor per pump to detect leakage of pumped product in the housing. Sensor shall be interlocked with the controls to signal an alarm and automatically shutdown the pump in the event of a tube or hose failure.

G. Accessories: The following accessories will be provided with each of the pumps. Material of construction shall be corrosion resistant and compatible with the liquids handled. The pressure rating shall be equal to or greater than the pump rating.
   1. Provide vented ball valves in accordance with Section 40 05 51.
   2. Quick connect Camlock.
   3. An in-line field adjustable-pressure, soft seat diaphragm-type relief valve with initial setting set at factory.
   4. A clear PVC calibration column with FNPT fittings top and bottom shall be provided for measuring pump output. Each column shall have height and diameter such that the measureable capacity of the column is approximately 30 seconds discharge of each pump at maximum pumping capacity or the maximum size column available. Permanently calibrate each column in gallons and tenths. Printed sticker labels will not be accepted. Contractor shall connect to drain stub-out provided by manufacturer from calibration column and route to chemical tote.
   5. Discharge pressure indicator with isolator, diaphragm type bolted design with bonded diaphragm to housing similar to Ashcroft 200. Pressure indicator shall be a minimum 3” diameter with an accuracy of ± 0.5% of span and bourdon and socket material of 316 stainless steel, liquid filled with corrosion resistant case ring. Fill fluid shall be compatible with chemical. Pressure range: 0-60 psi for tube pumps and 0-200 psi for hose pumps.
   6. Pressure switch to be NEMA 4X, corrosion resistant construction. Field adjustable set-point suitable for design pressures. Pressure switch shall be rated at 115VAC and will close on increasing pressure while signaling controller. Pressure indicator and pressure switch may share common isolator.
   7. Provide a low pressure switch indicating a plugged strainer and diaphragm as needed for Sodium Hypochlorite. Refer to PMID for location.

H. Skid Assembly: The Manufacturer shall provide and be responsible for assembly and testing the complete skid system. Pump, drive, control panel and accessories to be piped and wired on a common skid.
   1. Skid to be constructed of minimum ½” thick corrosion resistant FRP or HDPE with structural reinforcement to minimize deflection. Skid mounted assemblies are to include all accessories, pre-piped with drip rim, and gusseted vertical back panel to rigidly anchor and support controls, pump, and piping. The skid shall be able to withstand the weight of the mounted equipment including the chemical during operation and calibration. Pipe and equipment supports on the skid shall be constructed of 316 stainless steel. Anchor bolts shall be 316 stainless steel.
   2. Provide solvent welded Schedule 80 PVC piping and fittings in accordance with Section 40 05 31.13.
   3. Flexible hoses shall be suitable for the chemical specified and shall be provided for process connections to pumps to allow easy removal of pump tubes during maintenance.
   4. Provide skid to maximum dimensions of 36” deep x 54” wide x 60” tall and with process connections as shown on Contract Drawings. The pump, valves, and control panel shall be located on the skid such that they are easily accessible for operation and maintenance.
   5. Provide floor mounted skids. The Manufacturer shall provide brackets, anchors, etc. to support the floor mounted skid. At Manufacturer’s option, provide additional supports at no
additional cost to Owner. The Contractor shall coordinate with Manufacturer on the type, size and location of the skid supports designed and furnished.

2.02 CHEMICAL TOTES

A. Provide adequate storage of chemicals in tote(s) constructed of compatible materials; having inlet, outlet, drain, overflow, and other connections as shown on the Drawings; and provide level gauges, vents, signage, mixer mounts, and other tank accessories.

2.03 PUMP CONTROL PANEL

A. Pump controls shall be housed in a NEMA 4X FRP enclosure and shall meet the requirements of Divisions 26 and 40. All controls necessary for the full automatic operation shall be provided as a component of the metering pump equipment. A minimum of the following shall be provided for each pump:
1. Electrical Service 30A, 240V, 1 phase (3W, + G)
2. Main Disconnect.
3. Control switches and pushbuttons for the following:
   a. ON/OFF/REMOTE selector switch.
   b. Emergency STOP pushbutton, maintained contact closure with reset and interrupting all power equipment.
   c. Reset Alarm pushbutton.
4. Push-to-test indicating lights (or illuminated LCD, readable at an offset angle of 45 degrees) for the following:
   a. Run indication.
   b. Stop indication.
   c. Fault indication, panel alarm and common acknowledge button.
   d. Leak indication, panel alarm and common acknowledge button.
   e. High pressure indication, panel alarm and common acknowledge button.
5. Keypad for speed control. Capacity adjustment from 0 to 100% will be accomplished by an integral microprocessor based on meter speed controller.
6. Digital display of pump speed in gph units.
7. Elapsed time meter.
8. Circuit breaker, sized approximately for this application.
9. phase loss and undervoltage relay protection.
10. Chemical feed pump VFDs shall be designed for high temperature applications (122 degrees F)
11. Contacts for transmittal of signals to & from plant control panel:
   a. .
   b. Digital In - Run/Stop control from plant control panel for each pump based on which well pump is running.
   c. Digital Out - Run/Stop status to future SCADA.
   d. Digital Out – Leak detected status to future SCADA.
   e. Digital Out – General alarm status to future SCADA.
   f. Digital Out – Auto / manual Status to SCADA. Analog In - 4-20mA speed.
   g. .
   h. Digital In - Run/Stop.
i. Digital Out - Run/Stop to future SCADA.

j. Digital Out - High Pressure to future SCADA.

k. Digital Out – Leak to future SCADA.

l. Digital Out – Fault to future SCADA.

m. Digital Out - Remote Status to future SCADA.

PART 3 EXECUTION

3.01 INSTALLATION

A. All equipment and accessories shall be installed in accordance with the Manufacturer’s written recommendations, as approved by the Engineer, and as shown on the Drawings. Mount systems as indicated.

B. The Contractor shall be responsible for installing equipment that the Manufacturer could not ship assembled as an integral part of the system due to shipping restrictions. These items shall be identified on the Manufacturer’s approval drawings.

C. Do not begin fabrication or erection prior to submittal approval.

D. The peristaltic chemical metering pump factory certified service Engineer shall inspect the complete installation and provide written certification stating that the installation of the equipment is satisfactory. The certification must also indicate the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of the system.

3.02 FIELD INSPECTION AND PERFORMANCE TESTING

A. Functional Test: Prior to start-up, all equipment shall be inspected by the Manufacturer for proper alignment, quiet operation, proper connection and satisfactory performance.

B. Upon written certification from the metering pumps certified service Engineer that the equipment is approved for start-up, the system shall be placed into service in the presence of the Engineer.

C. If the system performance does not meet the Specifications, corrective measure shall be taken to satisfy the conditions specified.

D. Once the system is in operation and performing as specified, a 48-hour operating period will be required, with no interruptions of the equipment, before Owner acceptance and warranty initiation.

E. Any component parts which are damaged as a result of this testing or which fail to meet the requirements of these specifications shall be replaced, reinstalled and re-tested at the Contractor’s expense.

END OF SECTION
SECTION 43 42 21

WELDED STEEL PRESSURE TANK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work described by this Section consists of furnishing all equipment, materials, and labor to provide, install and test one welded steel hydropneumatic pressure tank for potable water storage and pressure control as shown on the Contract Drawings and specified in the Contract Documents.

1.02 RELATED WORK

A. Division 03 – Concrete
B. Division 09 – Painting and Coating
C. Division 26 – Electrical
D. Division 40 – Process Interconnections
E. Division 46 – Water and Wastewater Equipment

1.03 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Comply with the general requirements of the Uniform General Conditions and the supplemental requirements herein.
   2. Submit drawing or illustration showing unit construction for each type and size of hydropneumatic pressure tank.
   3. Submit the following information for each tank:
      a. Layout drawings shall be submitted and include the dimensions of all equipment, accessories, supports, connections, outlets, and all related piping.
      b. Equipment weights and anchor bolt designs.
      c. Submit design loads for the foundation design.
      d. Submit tank weld x-rays and hydrostatic test in accordance with 1.05(A)(2).
   4. If catalog bulletins are used to communicate above information, mark out inapplicable information.
   5. Submit Manufacturer’s operating and maintenance instructions in compliance with the General Conditions for equipment furnished under this section.
   6. Hydropneumatic pressure tanks shall meet NSF 61 requirements for contact with potable water.
   7. Tank manufacturer shall submit certificate that tank material is suitable for the service conditions specified herein.

1.04 REFERENCE STANDARDS

A. Standards referenced in this Section are listed below:
1. American National Standards Institute, (ANSI)
2. American Society of Mechanical Engineers, (ASME)
   a. Boiler and Pressure Vessel Code, (BPVC) Section VIII, Division 1
4. American Water Works Association (AWWA)
5. International Organization for Standardization, (ISO)
   a. ISO-9001, Requirements for Quality Management System

1.05 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:
   1. Manufacturer shall be ISO-9001 certified which includes engineering design,
      manufacturing, and testing complete components.
   2. Manufacturer shall provide in-house x-rays of welds, if ASME code requires it, and
      hydrostatic test. ASME inspection report and U1A form shall be sent to the Engineer prior
      to shipping the vessel. Engineer reserves the right to inspect the vessel manufacturing
      facility to confirm requirement above.
   3. Welders must be qualified by ASME Requirements in all positions and must hold a
      current certification.

B. Acceptable Manufacturers:
   1. Tank & Vessel Builders
   2. Bulldog Steel Products, Inc.,
   3. Or approved equal

1.06 SYSTEM DESCRIPTION/DESIGN REQUIREMENTS

A. General:
   1. The horizontal hydropneumatic tank must be located wholly above grade and must be of
      steel construction with welded seams.
   2. The horizontal steel hydropneumatic tank shall be provided with the manufacturer’s
      services at the jobsite at no additional cost to the Owner. One full 8-hour day of service
      from manufacturer’s representative shall be provided per tank to approve the tank
      installation and advise the Contractor during startup, testing, and final adjustment of each
      tank.
   3. All facilities and components must be constructed in accordance with the Texas
      Commission on Environmental Quality (TCEQ) Rules and Regulations for Public Water
      Systems 30 Texas Administrative Code (TAC) Chapter 290.
   4. Tank shall be NSF-PW Standard 61 compliant for potable water storage and compliant
      with all requirements of TAC 290.

B. Design Criteria
   1. Designed in accordance with AWWA Specifications D100 for dead load, live load and
      wind load and ASME Boiler and Pressure Vessel Code, Section VIII, Division I.
      a. Tank shall have ASME code stamp Section VIII. Tank shall be designed with 4:1
         factor of safety.
   2. Corrosion allowance for all steel plates in the wetted areas shall be 1/16-inch and shall be
      added to the minimum thickness.
3. Design pressure: 100 psig (minimum)
5. Walls – thickness to be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
6. Design (ambient) temperature: 25°F to 115°F

1.07 DELIVERY, HANDLING AND STORAGE

A. Handle materials so as to prevent damage.

B. Store materials on skids above ground and keep clean, properly drained, and protected from elements causing corrosion.

C. Store materials so as to prevent excessive deflection.

1.08 MAINTENANCE/ACCESSORIES/SPARE PARTS

A. Manufacturer/Supplier shall submit a complete listing of spare parts for all equipment furnished under this section.

1.09 WARRANTY

A. The equipment Manufacturer shall provide a one (1) year warranty, commencing on the date of substantial completion, for all parts associated with the equipment and the labor associated with repair and/or replacement of the parts. The warranty must be submitted during the shop drawing phase. Approval of the shop drawings will be contingent on the receipt of the warranty. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. This specification has been developed around a horizontal steel hydropneumatic tank as manufactured by Tank & Vessel Builders LP. Any related construction and/or design modifications necessitated due to the use of an alternate tank design shall be the responsibility of the Contractor.

B. Tank shall be constructed of new materials as specified and shown on the drawings. No used tank will be allowed.

2.02 FABRICATION

A. Tank shall conform to AWWA D100, Section 9.

B. The tank shall be a horizontal welded steel tank suitable for use with potable water.

C. Tank shall be provided with manway for maintenance access and lifting lugs.

D. Metal thickness shall be sufficient to withstand the highest expected working pressures with a four to one factor of safety.
E. The tank must meet the standards of the American Society of Mechanical Engineers (ASME) Section VIII, Division I Codes and Construction Regulations and must have an access port for periodic inspections. An ASME nameplate must be permanently attached to those tanks.

F. Tank hydraulic performance conditions and design criteria shall be as shown below.

<table>
<thead>
<tr>
<th>Tank Configuration:</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Capacity:</td>
<td>1200 gallons</td>
</tr>
<tr>
<td>Design (Ambient) Temperature Range:</td>
<td>25°F to 115°F</td>
</tr>
<tr>
<td>Design Pressure:</td>
<td>100 psig</td>
</tr>
<tr>
<td>Minimum Test Pressure:</td>
<td>150 psig</td>
</tr>
</tbody>
</table>

G. Hydropneumatic pressure tanks shall be painted, coated, disinfected, and maintained in strict accordance with current AWWA standards. Protective paint shall be applied to the outside of the tank and an NSF certified coating shall be applied to the inside portion of the tank. All painting and coatings shall be completed at the factory. Field painting and coating will not be accepted. No temporary coating, wax, grease coating or coating materials containing lead will be allowed. No other coating will be allowed which are not approved for use as a contact surface with potable water by the United States Environmental Protection Agency (EPA), National Sanitaion Foundation (NSF), the United States Food and Drug Administration (FDA). All newly installed coatings must conform to ANSI/NSF Standard 61 and must be certified by an organization accredited by ANSI. All surface areas on the vessel shall be inspected.

H. Associated appurtenances including valves, pipes, and fittings connected to pressure tanks must conform to ANSI/NSF International Standard 61 and shall be thoroughly tight against leakage. Maximum allowable lead content of pipes, pipe fittings, plumbing fittings, and fixtures is 0.25 percent.

2.03 ACCESSORIES

A. Pipe Connections

1. Inlet/Outlet – Provide 4-inch diameter flanged inlet/outlet nozzle as shown on the plans with baffle plate mounted in tank interior.
2. Drain – Provide a 2-inch diameter drain and cleanout with 2-inch ball valve.
3. Air Line and Water Line – Provide ½-inch diameter NPT (female) nozzles on top and bottom of tank.

B. Manway – Provide a pressure manway on one tank head end, of size to accommodate manned entry into the tank.

C. Tank shall be provided with a pressure release device on the roof of the tank, and an easily readable pressure gauge with isolation ball valve.

D. Facilities shall be provided for maintaining the air-water volume at the design water level and working pressure. Provide a tank-mounted air charging system with integral compressor, pressure switch, and level sensing electrode. Air charging system shall be Air Rite by WhiteWater Manufacturing or similar.

E. Air injection lines shall be equipped with filters or other devices to prevent compressor lubricant and other contaminants from entering the pressure tank.

F. A device to readily determine air-water volume shall be provided.
G. Saddle supports – tank manufacturer shall provide two saddle supports specifically designed to support the specified tank.

2.04 FACTORY TESTING (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION/PREPARATION (NOT USED)

3.02 INSTALLATION

A. The tanks shall be installed in accordance with the manufacturer's suggested procedures. All supports, piping, valves, and related appurtenances shall be provided and installed by the Contractor.

3.03 DISINFECTION

A. Contractor shall disinfect the tank after it has been painted, and all related components affected by the work in accordance with TCEQ Chapter 290 and current AWWA Standard C655-09 or most recent.

3.04 INSPECTION

A. After the tank is completed and before it is painted, welds shall be inspected and approved in the fabricator's shop by a Texas Registered Professional Engineer.

B. Welded joints shall be subjected to radiographic testing as described in Appendix A to AWWA Specification D100. Testing shall be verified in writing and shall be provided to the Engineer.

3.05 FIELD TESTING

A. When tank and piping are complete and disinfected, but prior to placing tank in service, the tank will be charged with water, pressure applied to maximum operating pressure and tank, piping, valves, and fittings observed for leakage or loss of pressure. No leakage will be allowed.

3.06 FIELD PAINTING

A. All painting and coating shall be completed at the factory. Field painting and coating will not be accepted.

3.07 CLEANING (NOT USED)

END OF SECTION
SECTION 46 00 01

EQUIPMENT GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK
   A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant Work, complete and operable, all in accordance with the requirements of the Contract Documents.
   B. The provisions of this Section will apply to all equipment specified and where referred to, except where otherwise specified or shown.
   C. In case of conflict between this specification section and individual equipment specification section, the stringent requirements shall govern.

1.02 SUBMITTALS
   A. Shop Drawings: The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the Engineer.
      1. Drawings showing general dimensions and conforming the size of equipment, drives and specified appurtenances, piping connections and construction details of equipment.
      2. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, part list with materials of construction by ASTM reference and grade, outline dimensions, and shipping weights.
      3. Submit methods and criteria used for calculating equipment anchorage forces and the capacities of the anchorage elements.
      4. Manufacturer’s installation instructions.
      5. Data, in accordance with Division 26 - Electrical - for the electric motors, proposed for each equipment.
      6. Variable speed drive information as required under Division 26 - Electrical.
      7. Elevations of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.
      8. Wiring diagrams of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
      10. Complete description and sketch of proposed test setup for factory test if a factory test is required by the requirements of this Section or Individual Equipment Section at least 60 days prior to proposed test date. Submittal material shall include sample calculations and proposed test log format.
      11. Factory Test Data: Signed, dated, and certified factory test data for each equipment system which requires factory testing, submitted four weeks prior to shipment of equipment.
   B. Certifications
      1. A Certificate of Unit Responsibility Assignment signed by officers of both the Contractor and the Equipment Manufacturer Corporations, attesting to the assignment of
responsibility in accordance with these Contract Documents. No other submittal material will be reviewed until the certificate has been submitted and found to be in conformance with these requirements.

2. If factory tests are required by these specifications, submit certification of satisfactory testing of each equipment unit as specified. The certified material shall include copies of test logs and resulting performance results at least four weeks prior to shipping the units from the factory. Submit certified calibration test results on all instruments used for conducting the factory tests.


4. Satisfactory field testing certification of the equipment units.

C. Owner’s Manual: Submit operation and maintenance manual. Operation and Maintenance Manuals shall include data for each equipment unit, including motor. The Owner’s Manual shall contain following:

1. Manufacturer’s written guarantee that equipment operates within the requirements specified in the Contract Documents.

2. If factory tests are required by these specifications, certified copies of test logs and resulting performance results shall be included in the manual. Certified calibration test results on all instruments used for conducting the factory tests shall also be included in the manual.

3. Vibration and noise measurement results.

4. Include in Owner’s Manual the procedures for shutting down and locking out all mechanical and electrical items that store or move hazardous energy when maintenance is required. Procedure should be as simple as possible.

1.03 REFERENCE STANDARDS

A. Except as otherwise indicated, the applicable standards of the following organizations apply to the Work of this Section:

2. American Public Health Association (APHA).
4. American Society of Mechanical Engineers (ASME).
5. American Water Works Association (AWWA).
6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
11. Antifriction Bearing Manufacturers Association (AFBMA).
14. Manufacturer’s published recommendations and specifications.
15. Occupational Safety and Health Administration (OSHA).

B. The following standards apply to the Work of this Section:

ASME B1.20.1 General Purpose Pipe Threads (Inch)
ASME B16.1  Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.5  Pipe Flanges and Flanged Fittings, NPS ½ Through NPS 24 Metric/Inch Standard
ASME B31.1  Power Piping
ASME B46.1  Surface Texture
ANSI/AWWA C206  Field Welding of Steel Water Pipe
ANSI/ASA S12.6  Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ASTM A 48  Specification for Gray Iron Castings
ASTM A 108  Specification for Steel Bars, Carbon, and Alloy Cold-Finished

1.04 QUALITY ASSURANCE

A. Manufacturer’s Qualifications

Unless otherwise acceptable to the Engineer, all equipment furnished shall have a record of at least 10 years of successful, trouble-free operation in similar applications, from the same Manufacturer.

B. Services of Manufacturer's Representative

Inspection, Startup, and Field Adjustment: The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the Manufacturer of each item of major equipment who shall visit the site of Work to perform the following tasks:

1. Assist the Contractor in the installation of the equipment.
2. To inspect, check, adjust if necessary and approve the equipment installation.
3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
5. Provide agenda for operation and maintenance training to the Owner’s Representative.
6. Instruction of the Owner’s Personnel:

   a. Where required by the individual equipment sections, an authorized training representative of the manufacturer shall visit the Site for the number of days indicated in those sections to instruct the Owner’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

   b. The representative shall have at least 2 years of experience in training. A resume of the representative shall be submitted.

   c. Training shall be scheduled 3 weeks in advance of the scheduled session.
d. Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the Engineer shall be incorporated into the material.

e. The training materials shall remain with the trainees after the session.

f. The Owner will videotape the training for later use by the Owner’s personnel.

7. Costs: The costs of all inspection, startup, testing, adjustment, and instruction Work performed by factory-trained representatives at the site shall be borne by the Contractor. When available, the Owner’s operating personnel will provide assistance in the field-testing.

C. Inspection: It shall be the responsibility of the Contractor to inform the local authorities, such as building and plumbing inspectors, Fire Marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, etc., to obtain all required permits and certificates, and pay all fees.

1.05 UNIT RESPONSIBILITY

A. Equipment systems made up of two or more components shall be provided as a unit by the Manufacturer of the driven equipment. The Manufacturer of the driven equipment shall assume the unit responsibility. Unless otherwise indicated, the Contractor shall cause each system component to be furnished by the Manufacturer with unit responsibility. The extent of the Manufacturer’s responsibilities shall include engineering the specified equipment, preparation of all submittals materials, coordinating manufacture and procurement process, compatibility and shipment of all specified components, design of all equipment support, providing installation and testing to assist the Contractor in completing the installation and commissioning the equipment, furnishing factory trained certified specialists to train the Owner’s staff, and the production and submission of specified operation and maintenance manuals. The Contractor is responsible to the Owner for performance of all systems as indicated. The Contractor shall ensure that the submittal of a Certificate of Unit Responsibility signed by the Manufacturer with unit responsibility.

1.06 DELIVERY, HANDLING AND STORAGE

A. The equipment manufacturer shall provide unloading, storage, and handling instructions to the Contractor prior to shipment.

B. Equipment delivered onsite without an accepted submittal will not be allowed to be unloaded.

C. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weather tight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

D. All equipment shall be delivered to the Contractor in good, sound condition, and free from damage. Equipment which has been damaged will be rejected. Equipment Manufacturer’s representative shall be on the site to witness the arrival, inspection, and unloading process if specified in individual specification section.

E. The Contractor shall be responsible for proper unloading, handling, and storage of all equipment in accordance with the Manufacturer’s instructions. Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
1.07 MAINTENANCE/SPARE PARTS

A. Tools: The Contractor shall supply one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright finish; wrench heads shall have work faces dressed to fit nuts. All tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover.

B. Spare Parts: All equipment shall be furnished with the manufacturer’s recommended spare parts as indicated in the individual equipment Sections. The Contractor shall also obtain and submit from the Manufacturer a list of suggested spare parts for each piece of equipment. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component. Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking hasp. Hinge shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and word “spare parts”. A neatly typed inventory of spare parts shall be taped to the underside of the cover. All spare parts are intended for use by the Owner only, after expiration of the warranty period specified in the Contract Documents.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Noise Level: When in operation, no piece of equipment shall exceed the OSHA noise level requirements for one hour exposure.

1. High Noise Level Location: The Contractor shall provide one personal hearing protection, as specified herein, at each high noise level location. This requirement shall not relieve the Contractor from meeting noise level requirements specified in the Contract Documents. The high noise level locations are defined as follows:

   a. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2-hour exposure of 100 dBA. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station.

   b. Indoor Location:

      i. Any single equipment item, or any group of items, located within a single room normally occupied, that produces noise exceeding OSHA noise level requirements for a 2-hour exposure.

      ii. Any single equipment item, or any group of items, located within a single room normally occupied by workers that produces noise exceeding OSHA noise level requirements for 8-hour exposure.

B. Personal Hearing Protection: The Contractor shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors. The ear protectors shall be capable of meeting the requirements of ANSI/ASA S12.6 and shall produce a noise level reduction of 25
dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the Contractor and mounted in an approved location near the noise producing equipment.

C. Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components in accordance with AGMA. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives.

D. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear manufacturer sizing information.

E. Where load classifications are not indicated, service factors shall be for standard load classifications and for flexible couplings.

F. Welding: Unless otherwise specified or shown, all welding shall conform to the following:
1. Latest revision of applicable AWS Welding Code
2. Latest revision of ANSI/AWWA C206.
3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
4. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same. Submit welders' qualifications.
5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

G. Protective Coating: All equipment shall be painted or coated in accordance with Division 09 specifications, unless otherwise indicated. Non-ferrous metal and corrosion resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

H. Identification of Equipment Items: Each item of equipment shipped shall have an indelible, legible identifying mark corresponding to the equipment number shown or specified for the particular item.

I. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per Manufacturer's written recommendations.

J. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Engineer's accepted shop drawings.

K. Tolerances: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled
ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.

L. Castings: Castings shall be homogenous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The Engineer shall be notified of larger defects. No repair welding of such defects shall be carried out without the Engineer's written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then the casting may be rejected. Costs of casting new material shall be the Contractor's responsibility as part of the Work.

M. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
   1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
   2. Surface roughness shall not exceed 250 micro-inches except where a tight joint is indicated.
   3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
   4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

2.02 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports must bear the signature and seal of an Engineer licensed in the State where the Project is to be built, unless otherwise indicated. Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, and normal operation plus wind loadings.

1. Wall-mounted equipment weighing more than 250 pounds or which is within 18-inches above the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

2. Seismic requirements: Freestanding and wall-hung equipment shall be anchored in place by methods that satisfy the building code. Calculations shall be performed and signed and stamped for equipment weighing more than 400 pounds. Calculations shall analyze lateral and overturning forces and meet all applicable building code requirements. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

3. Wind requirements: Exterior freestanding equipment shall be anchored in place by methods that satisfy the building code. Calculations shall be performed and signed and stamped, analyzing lateral and overturning forces and meet all applicable building code requirements. Calculations shall include the distribution of forces imposed on the
supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

B. Anchors: Anchor bolts shall be in accordance with Division 05 specifications and all Manufacturer’s recommendations. In the event that requirements are conflicting, the more stringent requirements shall apply. Contractor shall determine the size, type, capacity, location and other placement requirements of anchorage elements. Anchoring methods and leveling criteria shall be followed as per manufacturer’s literature.

C. Equipment Foundations: Equipment foundations shall be as shown in the Drawings and in accordance with Manufacturer’s written recommendations. In the event that requirements are conflicting, the more stringent requirements shall apply. All mechanical equipment, tanks, control cabinets, etc., shall be supported as shown in the Drawings, unless otherwise specified.

2.03 PIPE HANGERS, SUPPORTS, AND GUIDES

A. All pipe connections to equipment shall be supported, anchored, and guided to minimize stresses and loads on equipment flanges and equipment. Supports and hangers shall comply with the requirements of Section 40.05.07 Hangers and Supports for Process Piping.

2.04 FLANGES AND PIPE THREADS

A. All flanges on equipment and appurtenances provided under this Section shall conform to ASME B16.1, Class 125; or B16.5, Class 150, unless otherwise shown. All pipe threads shall be in accordance with ASME B1.20.1.

2.05 COUPLINGS

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed. Unless otherwise indicated, or recommended by the equipment manufacturer, gear or flexible spring type coupling shall be furnished with horizontal and end suction pumps.

B. The equipment manufacturer shall recommend the size and type of coupling required to suit each specific application.

C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.

D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.06 SHAFTING

A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Design Criteria: Shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of 2 in the endurance limit and the stress
concentration factor of the fillets in the shaft and keyway. Stress concentration factor shall be in accordance with ASME Standard B17.1 – Keys and Keyseats.

C. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as shown or specified unless furnished as part of an equipment assembly.
   1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
   2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.
   3. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

D. Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, an extension shaft with two sets of universal type couplings shall be provided.

2.07 BEARINGS

A. General: Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. All lubricated-for-life bearings shall be factory-lubricated with the Manufacturer’s recommended grease to insure maximum bearing life and best performance.

E. Bearing Life: Except where otherwise specified or shown, all bearings shall have a minimum L-10 life expectancy of 80,000 hours.

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the Manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.08 GEARS AND GEAR DRIVES

A. Unless otherwise specified, gears shall be of the spur, helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 80,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically acceptable to the Engineer.

B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.

C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be left to the discretion of the Manufacturer. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-
matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.

F. Where gear drive input or output shafts connect to couplings or sprockets supplied by others, the gear drive Manufacturer shall supply matching key taped to the shaft for shipment.

2.09 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains complying with ANSI standards and of materials best suited for the process fluid.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.

2.10 SPROCKETS

A. Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. Materials: Sprockets shall comply with the following unless otherwise specified elsewhere:
   1. Sprockets with 25 teeth or less, normally used as a driver, shall be medium carbon steel in the 0.40 to 0.45 percent carbon range.
   2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
   3. Large diameter sprockets with Type C hub shall be cast iron conforming to ASTM A48, Class 30.

C. Sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be provided complete with keyseat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be provided with taper-lock bushings as required.

F. Idler sprockets shall be provided with brass or Babbit bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws in both sides of the hub shall be provided.

2.11 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.

B. Unless otherwise specified, sheaves shall be machined from the finest quality gray cast iron.
C. Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may require to be of special materials and construction recommended by the manufacturer.

D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper lock or QD bushings as required.

E. Finish bored sheaves shall be furnished complete with keyseat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.12 DRIVE GUARDS

A. Power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded in accordance with the OSHA Safety and Health Standards (29CFR1910.211 to 1910.219). The guards shall be constructed of minimum 10 gauge expanded; flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.13 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment with the requirements of the ANSI B31.1.

2.14 INSULATING CONNECTIONS

A. Insulating bushings, unions, couplings, and flanges, shall comply with the requirements of Section 40 05 01 - Piping Specialties.

2.15 GASKETS AND PACKINGS

A. Gaskets for flanged connections shall comply with the requirements of Section 40 05 01 - Piping Specialties.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, or John Crane "Everseal".

C. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the Manufacturer and acceptable to the Engineer.

2.16 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Adhesives shall not be used in lieu of stainless steel screws. Nameplates shall contain the Manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.17 SAFETY REQUIREMENTS

A. Where Work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with approved breathing apparatus.
PART 3 EXECUTION

3.01 INSTALLATION

A. General: Equipment shall be installed in accordance with the manufacturer's written recommendations and the requirements of the individual equipment specification sections.

B. Alignment: Journeymen millwrights shall perform alignment of equipment furnished under this Section. The Owner's Field Representative will witness final alignment procedures of equipment.

C. Field Assembly: Studs, cap screws, bolt and nuts used in field assembly shall be coated with Never Seize compound or equal.

D. Welding: Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface.

E. Insulating Connections: All insulating connections shall be installed in accordance with the Manufacturer's printed instructions.

F. Pipe Hangers, Supports, and Guides: Hangers, supports, and guides shall be spaced in accordance with Section 40 05 07 – Hangers and Supports for Process Piping, as shown on the drawings and ANSI/ASME B.31.1 standard.

3.02 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.

B. If the packaged system has any additional features (as safety interlocks, etc.) other than required by the Contract Documents, the Contractor shall coordinate such features with the Engineer and provide material and labor necessary for a complete installation as required by the manufacturer.

3.03 FIELD TESTS

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.

B. The following field testing shall be conducted:
   1. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.
   2. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

C. The Engineer will witness field-testing. The Contractor shall notify the Engineer of the test schedule 5 working days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

END OF SECTION