

SECTION 01 11 13

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. This Section includes the following Articles:

<u>Article</u>	<u>Title</u>
1.1	Section Includes
1.2	Location and Description of Work
1.3	Work by Others
1.4	Work by OWNER
1.5	Sequence and Progress of Work
1.6	CONTRACTOR's Use of Site
1.7	Easements and Rights-of-Way
1.8	Notices to Owners and Authorities of Properties Adjacent to the Work
1.9	Salvage of Materials and Equipment

1.2 LOCATION AND DESCRIPTION OF WORK

- A. The Work is located at the Beardsley Pump Station, 119 White Plains Road, Trumbull CT 06611.
- B. The Work to be performed under this Contract includes, but is not limited to, constructing the Work described below and all related appurtenances. The Work includes, but is not limited to, the following:
1. New pumps and piping.
 2. New electrical and control systems.
 3. New standby generator.
 4. Bypass pumping around existing pump station.
 5. All demolitions, removals and associated electrical, structural, architectural and mechanical construction as more fully described in these specifications and on the Drawings to provide completely operational systems.
- C. Contracting Method: The Project shall be constructed under one prime Contract.
- D. Hazardous Environmental Conditions:
1. To the best of Owner's knowledge, information, and belief, the Site has been a wastewater pumping station since 1972.

2. A Hazardous Environmental Condition, described in reports referenced in the Supplementary Conditions, will affect the Work.

1.3 WORK BY OTHERS

- A. New main utility connections for the pump station shall be coordinated with and completed by the United Illuminating (UI) Company. UI to provide electrical meter, transformer, wire, connections, and appurtenances for the station. CONTRACTOR responsible for all coordination and costs associated with the electrical service for the station.
- B. New natural gas service connection shall be provided for the pump station and shall be coordinated with and completed by Southern Connecticut Gas Company (SCG). SCG to provide meter, connections, piping up to the meter and appurtenances for the station. CONTRACTOR responsible for all coordination and costs associated with the gas service for this station.

1.4 WORK BY OWNER

- A. OWNER will perform the following in connection with the Work:
 1. Operate all existing valves, gates, pumps, equipment, and appurtenances that will affect OWNER's operation, unless otherwise specified or indicated.

1.5 SEQUENCE AND PROGRESS OF WORK

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

1.6 CONTRACTOR'S USE OF SITE

- A. CONTRACTOR will have full use of the Site for storage and operations of workers related to the Project.
- B. Move stored materials and equipment that interfere with operations of OWNER, other contractors, and others performing work for OWNER.
- C. Limits on CONTRACTOR's use of the Site are:
 1. Contractor shall maintain access to Beardsley Park for the duration of the work.
 2. Do not use the Site for operations other than those required for the Project.
 3. Connecticut Department of Energy and Environmental Protection (CTDEEP) has determined that known extant populations of State Special Concern Terrapene carolina (eastern box turtle) are in the vicinity of the project site. CONTRACTOR shall reference attached correspondence from CTDEEP and

follow recommended protection strategies for turtles in the completion of the Work.

1.7 EASEMENTS AND RIGHTS-OF-WAY

A. General:

1. Easements and rights-of-way required for the permanent improvements included in the Work will be provided by OWNER in accordance with the General Conditions and Supplementary Conditions.
2. Confine construction operations within OWNER's property, public rights-of-way, easements obtained by OWNER, and limits shown, and property for which CONTRACTOR has made arrangements directly with property owner(s).
3. Use care in placing construction tools, equipment, excavated materials, and materials and equipment to be incorporated into the Work to avoid damaging property and interfering with traffic.
4. Do not enter private property outside the construction limits without permission from the owner of the property.

B. Within Highway Rights-of-Way:

1. Permits required for the permanent facilities will be obtained by OWNER. CONTRACTOR shall obtain and pay for work permits and fees for safety and inspection forces to be furnished by the right-of-way owner.
2. Work performed and CONTRACTOR's operations within limits of highway rights-of-way shall comply with requirements of highway owner and applicable work permits, or authority having jurisdiction over right-of-way.

1.8 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK

- A. Notify owners of adjacent property and utility owners when prosecution of the Work may affect their property, facilities, or use of property.
- B. When it is necessary to temporarily obstruct access to property, or when utility service connection will be interrupted, provide notices sufficiently in advance to enable affected persons to provide for their needs. Such notifications shall comply with Laws and Regulations and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.
- C. Notify utility owners and other concerned entities not less than 72 hours prior to cutting or closing streets or other traffic areas or excavating near Underground Facilities or exposed utilities.

1.9 SALVAGE OF MATERIALS AND EQUIPMENT

- A. Existing materials and equipment removed and not shown or specified to be reused in the Work will become CONTRACTOR's property, except the following items that shall remain OWNER's property:
 - 1. Stop Planks.
- B. Existing materials and equipment removed by CONTRACTOR shall not be reused in the Work, except for the following:
 - 1. MISSION Control Panel.
- C. Removal, Storage, Handling, Reinstallation:
 - 1. Carefully remove in manner to prevent damage all materials and equipment shown or indicated to be salvaged and reused or to remain property of OWNER.
 - 2. Store and protect salvaged items shown or indicated to be used in the Work.
 - 3. Replace in-kind or with new items those items of materials and equipment damaged during removal, storage, or handling through CONTRACTOR's actions, negligence, or improper procedures.
- D. CONTRACTOR may furnish and install new items, with ENGINEER's approval, instead of those specified or indicated to be salvaged and reused, in which case such removed items will become CONTRACTOR's property.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +



Connecticut Department of

**ENERGY &
ENVIRONMENTAL
PROTECTION**

August 28, 2017

Ms. Julie K. Bjorkman
JBK Consulting, LLC
18 Crowley Drive
Old Saybrook, CT 06475
Julie_bjorkman@yahoo.com

Project: Municipal Upgrades to the Beardsley Pump Station, 119 White Plains Rd, Trumbull, Connecticut
NDDB Determination No.: 201706334

Dear Julie,

I have reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map you provided for the proposed Municipal Upgrades to the Beardsley Pump Station, 119 White Plains Rd, Trumbull s, Connecticut. According to our records we have known extant populations of State Special Concern *Terrapene carolina* (eastern box turtle) in the vicinity of the project site.

Eastern Box Turtle: Eastern box turtles inhabit old fields and deciduous forests, which can include power lines and logged woodlands. They are often found near small streams and ponds. The adults are completely terrestrial but the young may be semiaquatic, and hibernate on land by digging down in the soil from October to April. They have an extremely small home range and can usually be found in the same area year after year. Eastern box turtles have been negatively impacted by the loss of suitable habitat. Some turtles may be killed directly by construction activities, but many more are lost when important habitat areas for shelter, feeding, hibernation, or nesting are destroyed. As remaining habitat is fragmented into smaller pieces, turtle populations can become small and isolated. Reducing the frequency that motorized vehicles enter box turtle habitat would be beneficial in minimizing direct mortality of adults.

Recommended Protection Strategies for Turtles:

Work should occur when these turtles are active (April 1st to September 30th). Conducting land clearing while the turtle is active will allow the animal to move out of harm's way and minimize mortality to hibernating individuals. I recommend the additional following protection strategies in order to protect this turtle:

- Exclusionary practices will be required to prevent any turtle access into construction areas. These measures will need to be installed at the limits of disturbance.
- Exclusionary fencing must be at least 20 in tall and must be secured to and remain in contact with the ground and be regularly maintained (at least bi-weekly and after major weather events) to secure any gaps or openings at ground level that may let animal pass through. Do not use plastic netted silt-fence.
- All staging and storage areas, outside of previously paved locations, regardless of the duration of time they will be utilized, must be reviewed to remove individuals and exclude them from re-entry.

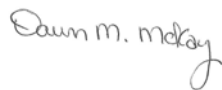
- All construction personnel working within the turtle habitat must be apprised of the species description and the possible presence of a listed species, and instructed to relocate turtles found inside work areas or notify the appropriate authorities to relocate individuals.
- Any turtles encountered within the immediate work area shall be carefully moved to an adjacent area outside of the excluded area and fencing should be inspected to identify and remove access point.
- In areas where silt fence is used for exclusion, it shall be removed as soon as the area is stable to allow for reptile and amphibian passage to resume.
- No heavy machinery or vehicles may be parked in any turtle habitat.
- Special precautions must be taken to avoid degradation of wetland habitats including any wet meadows and seasonal pools.
- The Contractor must search the work area each morning prior to any work being done.
- When felling trees adjacent to brooks and streams please cut them to fall away from the waterway and do not drag trees across the waterway or remove stumps from banks.
- Avoid and limit any equipment use within 50 feet of streams and brooks.
- Any confirmed sightings of box, wood or spotted turtles should be reported and documented with the NDDB (nddbrequestdep@ct.gov) on the appropriate special animal form found at (http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav_GID=1641)

If these protection strategies are followed then the proposed activities will lessen the impact on this state-listed species. This determination is good for two years. Please re-submit an NDDB Request for Review if the scope of work changes or if work has not begun on this project by August 28, 2019.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Natural History Survey and cooperating units of DEEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

Please contact me if you have further questions at (860) 424-3592, or dawn.mckay@ct.gov. Thank you for consulting the Natural Diversity Data Base. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to DEEP for the proposed site.

Sincerely,



Dawn M. McKay
Environmental Analyst 3

WILDLIFE IN CONNECTICUT

STATE SPECIES OF SPECIAL CONCERN

Eastern Box Turtle

Terrapene carolina carolina

Description

The eastern box turtle is probably the most familiar of the 8 species of turtles found in Connecticut's landscape. It is known for its high-domed carapace (top shell). The carapace has irregular yellow or orange blotches on a brown to black background that mimic sunlight dappling on the forest floor. The plastron (under shell) may be brown or black and may have an irregular pattern of cream or yellow. The length of the carapace usually ranges from 4.5 to 6.5 inches, but can measure up to 8 inches long. The shell is made up of a combination of scales and bones, and it includes the ribs and much of the backbone.

Each individual turtle has distinctive head markings. Males usually have red eyes and a concave plastron, while females have brown eyes and a flat plastron. Box turtles also have a horny beak, stout limbs, and feet that are webbed at the base. This turtle gets its name from its ability to completely withdraw into its shell, closing itself in with a hinged plastron. Box turtles are the only Connecticut turtle with this ability.

Range

Eastern box turtles are found throughout Connecticut, except at the highest elevations. They range from southeastern Maine to southeastern New York, west to central Illinois, and south to northern Florida.

Habitat and Diet

In Connecticut, this terrestrial turtle inhabits a variety of habitats, including woodlands, field edges, thickets, marshes, bogs, and stream banks. Typically, however, box turtles are found in well-drained forest bottomlands and open deciduous forests. They will use wetland areas at various times during the season. During the hottest part of a summer day, they will wander to find springs and seepages where they can burrow into the moist soil. Activity is restricted to mornings and evenings during summer, with little to no nighttime activity, except for egg-



laying females. Box turtles have a limited home range where they spend their entire life, ranging from 0.5 to 10 acres (usually less than 2 acres).

Box turtles are omnivorous and will feed on a variety of food items, including earthworms, slugs, snails, insects, frogs, toads, small snakes, carrion, leaves, grass, berries, fruits, and fungi.

Life History

From October to April, box turtles hibernate by burrowing into loose soil, decaying vegetation, and mud. They tend to hibernate in woodlands, on the edge of woodlands, and sometimes near closed canopy wetlands in the forest. Box turtles may return to the same place to hibernate year after year. As soon as they come out of hibernation, box turtles begin feeding and searching for mates.

The breeding season begins in April and may continue through fall. Box turtles usually do not breed until they are about 10 years old. This late maturity is a result of their long lifespan, which can range up to 50 to even over 100 years of age. The females do not have to mate every year to lay eggs as they can store sperm for up

to 4 years. In mid-May to late June, the females will travel from a few feet to more than a mile within their home range to find a location to dig a nest and lay their eggs. The 3 to 8 eggs are covered with dirt and left to be warmed by the sun. During this vulnerable time, skunks, foxes, snakes, crows, and raccoons often raid nests. Sometimes, entire nests are destroyed. If the eggs survive, they will hatch in late summer to early fall (about 2 months after being laid). If they hatch in the fall, the young turtles may spend the winter in the nest and come out the following spring.

As soon as the young turtles hatch, they are on their own and receive no care from the adults. This is a dangerous time for young box turtles because they do not develop the hinge for closing into their shell until they are about 4 to 5 years old. Until then, they cannot entirely retreat into their shells. Raccoons, skunks, foxes, dogs, and some birds will prey on young turtles.

Conservation Concerns

The eastern box turtle was once common throughout the state, mostly in the central Connecticut lowlands. However, its distribution is now spotty, although where found, turtles may be locally abundant. Because of the population decline in Connecticut, the box turtle was added to the state's List of Endangered, Threatened, and Special Concern Species when it was revised in 1998. It is currently listed as a species of special concern. The box turtle also is protected from international trade by the 1994 CITES treaty. It is of conservation concern in all the states where it occurs at its northeastern range limit, which includes southern New England and southeastern New York.

Many states have laws that protect box turtles and prohibit their collection. In Connecticut, eastern box turtles **cannot** be collected from the wild (DEP regulations 26-66-14A). Another regulation (DEP regulations 26-55-3D) "grandfathers" those who have a **box turtle collected before 1998**. This regulation limits possession to a single turtle collected before 1998. These

regulations provide some protection for the turtles, but not enough to combat some of the even bigger threats these animals face. The main threats in Connecticut (and other states) are loss and fragmentation of habitat due to deforestation and spreading suburban development; vehicle strikes on the busy roads that bisect the landscape; and indiscriminate (and now illegal) collection of individuals for pets.

Loss of habitat is probably the greatest threat to turtles. Some turtles may be killed directly by construction activities, but many more are lost when important habitat areas for shelter, feeding, hibernation, or nesting are destroyed. As remaining habitat is fragmented into smaller pieces, turtle populations can become small and isolated.

Adult box turtles are relatively free from predators due to their unique shells. The shell of a box turtle is extremely hard. However, the shell is not hard enough to survive being run over by a vehicle. Roads bisecting turtle habitat can seriously deplete the local population. Most vehicle fatalities are pregnant females searching for a nest site.

How You Can Help

- *Leave turtles in the wild. They should never be kept as pets. Whether collected singly or for the pet trade, turtles that are removed from the wild are no longer able to be a reproducing member of a population. Every turtle removed reduces the ability of the population to maintain itself.*
- *Never release a captive turtle into the wild. It probably would not survive, may not be native to the area, and could introduce diseases to wild populations.*
- *Do not disturb turtles nesting in yards or gardens.*
- *As you drive, watch out for turtles crossing the road. Turtles found crossing roads in June and July are often pregnant females and they should be helped on their way and not collected. Without creating a traffic hazard or compromising safety, drivers are encouraged to avoid running over turtles that are crossing roads. Also, still keeping safety precautions in mind, you may elect to pick up turtles from the road and move them onto the side they are headed. Never relocate a turtle to another area that is far from where you found it.*
- *Learn more about turtles and their conservation concerns. Spread the word to others on how they can help Connecticut's box turtle population.*



State of Connecticut
Department of Environmental Protection
Bureau of Natural Resources
Wildlife Division
www.ct.gov/dep



The production of this Endangered and Threatened Species Fact Sheet is made possible by donations to the Connecticut Endangered Species/Wildlife Income Tax Checkoff Fund.

SECTION 01 14 16

COORDINATION WITH OWNER'S OPERATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. This Section includes requirements for coordinating with OWNER's operations during the Project, and includes requirements for tie-ins and shutdowns necessary to complete the Work without impact on OWNER's operations except as allowed in this Section.
 - 2. CONTRACTOR shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to coordinate with OWNER's operations during the Work in accordance with this Section.
- B. Coordination:
 - 1. Review construction procedures under other Specifications sections and coordinate Work that will be performed with or before the Work specified in this Section.
- C. Related Sections:
 - 1. Section 01 11 13 , Summary of Work.
 - 2. Section 01 51 41, Temporary Pumping.
 - 3. Section 01 73 29, Cutting and Patching.
 - 4. Section 01 73 24, Connections to Existing Facilities.
- D. Except for shutdowns specified in this Section, perform the Work such that OWNER's facilities remain in continuous satisfactory operation during the Project. Schedule and conduct the Work such that the Work does not: impede OWNER's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, cause odors or other nuisances, or affect the public health, safety, and convenience.
- E. Work not specifically covered in this Section or in referenced Sections may, in general, be completed, within the Contract Times, at any time during regular working hours in accordance with the Contract Documents, subject to the requirements in this Section.
- F. As a substitute to the procedures specified in this Section, CONTRACTOR may propose providing additional temporary facilities that can eliminate or mitigate a constraint without additional cost to OWNER, provided such additional temporary facilities: do not present hazards to the public, personnel, structures, and equipment; that such additional temporary facilities do not adversely affect

OWNER's ability to comply with Laws and Regulations, permits, and operating requirements; that such temporary facilities do not generate or foster the generation of odors and other nuisances; and that requirements of the Contract Documents are fulfilled.

- G. Coordinate shutdowns with OWNER and ENGINEER. When possible, combine multiple tie-ins into a single shutdown to reduce impacts on OWNER's operations and processes.
- H. Operation of Existing Systems and Equipment during the Work:
 - 1. Do not shut off or disconnect existing operating systems or equipment, unless accepted by ENGINEER in writing.
 - 2. Operation of existing systems and equipment will be by OWNER unless otherwise specified or indicated.
 - 3. Where necessary for the Work, CONTRACTOR shall seal or bulkhead OWNER-operated gates and valves to prevent leakage that may affect the Work, OWNER's operations, or both.
 - 4. Provide temporary watertight plugs, bulkheads, and line stops as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of ENGINEER.
- I. Requirements for temporary pumping are in Section 01 51 41, Temporary Pumping and shown or indicated on the Drawings. Requirements for temporary pumping associated with specific shutdowns are indicated in this Section.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Substitute Sequence Submittal: When deviation from specified sequence or procedures is proposed, furnish submittal explaining in detail the proposed sequence or procedures and associated effects, including evidence that OWNER's operations will not be adversely affected, to an extent greater than originally contemplated in the Contract Documents, by proposed substitution. List benefits of proposed substitution, including benefits to Progress Schedule. Submit in accordance with Section 01 25 00, Substitution Procedures, and other requirements of the Contract Documents regarding substitution requests.
- B. Informational Submittals: Submit the following:
 - 1. Shutdown Planning Submittal:
 - a. For each shutdown, submit an inventory of labor, materials, and equipment required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for OWNER to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.

- b. Furnish submittal to ENGINEER not less than 30 days prior to proposed shutdown start date. Do not start shutdown until obtaining ENGINEER's acceptance of shutdown planning submittal.
2. Shutdown Notification: After ENGINEER's acceptance of shutdown planning submittal and prior to starting the shutdown, submit written notification to OWNER and ENGINEER of date and time each shutdown is to start. Submit notification not less than 72 hours in advance of each shutdown.

1.3 GENERAL CONSTRAINTS

- A. Indicated in the Contract Documents are the sequence and shutdown durations, where applicable, for OWNER'S equipment, systems, and conduits (including piping and ducting) that are to be taken out of service temporarily for the Work. New materials, equipment, and systems may be used by OWNER after the specified field quality controls and testing are successfully completed and the materials or equipment are Substantially Complete in accordance with the Contract Documents.
- B. The following constraints apply to coordination with OWNER's operations:
 1. Operational Access: OWNER'S personnel shall have access to equipment and areas of the facility that remain in operation.
 2. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated, and ventilated spaces in areas of the facility that are adjacent to the Work and that must be kept operational. Comply with Section 01 51 05, Temporary Utilities.
 3. Schedule and perform equipment and system start-ups for Monday through Thursday. Equipment and systems shall not be placed into operation on Friday, Saturday, and Sunday without prior approval of OWNER, unless specifically indicated otherwise in the Contract Documents.
 4. Dead End Valves or Conduits: Provide blind flanges, watertight bulkheads, or valve at temporary and permanent terminuses of conduits, including piping and ducting. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or otherwise restrained as directed by ENGINEER. Temporary valves shall be suitable for their associated service. Where valve is provided at permanent terminus of conduit, including piping or ducting, also provide on downstream side of valve a blind flange with drain/flushing connection.
 5. Draining and Cleaning of Conduits, Tanks, and Basins:
 - a. Unless otherwise shown or indicated, CONTRACTOR shall dewater process tanks, basins, conduits (including piping) at beginning of each shutdown. Flush, wash down, and clean tanks, basins, conduits (including piping), and other work areas.
 - b. CONTRACTOR shall remove liquids and solids and dispose of them at appropriate location. Unless otherwise specified or indicated, contents of tanks, basins, and conduits (including piping) undergoing modifications shall be transferred to existing process tanks or conduits

- at the Site with capacity sufficient to accept such discharges, using hoses, temporary piping, temporary pumps, or other means provided by CONTRACTOR. Discharge of fluids across floors is not allowed.
- c. If drainage point is not available on the conduit (including piping) to be drained, provide a wet tap using tapping saddle and valve or other method approved by ENGINEER. Uncontrolled spillage of contents of conduits (including piping) is not allowed.
 - d. Spillage shall be brought to ENGINEER's attention immediately, both verbally and in writing, and reported in accordance with Laws and Regulations. CONTRACTOR shall wash down spillage to floor drains or sumps or other appropriate location and flush the system to prevent clogging and odors. If spillage is not suitable for discharge to the drainage system, such as chemical spills, as determined by ENGINEER, CONTRACTOR shall remove spillage by other method, such as vacuum truck, sorbents, or other method acceptable to ENGINEER.

1.4 SEQUENCE OF WORK

- A. Perform the Work in the indicated sequence. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if OWNER's operations are not adversely affected by proposed sequence change, with ENGINEER's acceptance. Stages specified in this Article 1.4 are sequence-dependent.
- B. Stage I:
 - 1. Obtain all necessary permits.
 - 2. Coordinate with utilities for provision of new electric and natural gas service.
 - 3. Submittals and procurement for long lead items.
 - 4. Install Soil Erosion and Sediment Control Measures.
- C. Stage II:
 - 1. Install pump around connection on existing Force Main.
 - 2. Begin temporary pump around and isolate pump station from collection system.
 - 3. Clean influent channels and wet wells and removal all contents.
 - 4. Wall penetration and piping installation for installation of suction side temporary pump around connection on Wet Well No. 1.
 - 5. Remove existing parshall flume.
 - 6. Repair all concrete as required.
 - 7. Install bar screens, grinders (if awarded as Bid Alternate), wet well isolation gates.
 - 8. Perform surface repairs and epoxy coating and install new cover system (if awarded as Bid Alternate).

9. Install new pump discharge header in the Dry Well including discharge side plug valves. Connect to existing Force Main.
10. Complete required work in wet well and resume existing pump operation by temporarily connecting discharges to new discharge header.
11. Wet Well No. 3 to remain isolated.

C. Stage III:

1. Demolish existing pump discharge header in the Dry Well.
2. Install new Wall Penetration in Wet Well No. 3, suction piping, and concrete supports for Pump No. 4.
3. Install Pump No. 4 and all piping and appurtenances including instrumentation.
4. Perform all work required to install and test new Electrical Equipment and Main Control Panel.
5. Test and checkout Pump No. 4.
7. Bring Wet Well No. 3 back into service.

D. Stage IV:

1. Isolate Wet Well No. 2 and demolish existing Pump No. 2.
2. Install new Wall Penetrations in Wet Well No. 2, suction piping, and concrete supports for Pump Nos. 2 and 3.
3. Install Pump Nos. 2 and 3 including all piping and appurtenances including instrumentation.
4. Test and checkout Pump Nos. 2 and 3.
5. Bring Wet Well No. 2 back into service.

E. Stage V:

1. Isolate Wet Well No. 1 and demolish existing Pump No. 1.
2. Install new Wall Penetration in Wet Well No. 1, suction piping, and concrete supports for Pump No. 1.
3. Install Pump No. 1 and all piping and appurtenances including instrumentation.
4. Test and checkout Pump No. 1.
5. Bring Wet Well No. 1 back into service.

F. Stage VI:

1. Install new Odor Control System (if awarded as Bid Alternate).
2. Complete all sitework, including but not limited to demolition of underground storage tank, grading, paving, and construction of exterior concrete equipment pads.
3. Complete installation of new gas service. Install and test new standby generator.
4. Demolish existing and install new electrical equipment and lighting.
5. Perform demolitions and install new HVAC and plumbing systems.
6. Perform demolitions and architectural improvements.

1.5 TIE-INS

- A. Table 01 14 16-A in this Section lists connections by CONTRACTOR to existing facilities. Table 01 14 16-A may not include all tie-ins required for the Work; CONTRACTOR shall perform tie-ins required to complete the Work as shown or indicated regardless of whether tie-in is indicated in Table 01 14 16-A. For tie-ins not indicated in Table 01 14 16-A, obtain requirements for tie-ins from ENGINEER by requesting an interpretation or clarification.

1.6 SHUTDOWNS

A. General:

1. Terminology: A “shutdown” is when a portion of the normal operation of OWNER’s facility, whether equipment, systems, conduit (including piping and ducting), has to be temporarily suspended or taken out of service to perform the Work.
2. Work that may interrupt normal operations shall be accomplished at times convenient to OWNER unless otherwise indicated in the Contract Documents.
3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, materials, equipment, spare parts, both temporary and permanent, necessary to successfully perform the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to commencing the associated shutdown. Demonstrate to ENGINEER’s satisfaction that CONTRACTOR has complied with such requirements before commencing the shutdown.
4. If CONTRACTOR’s operations cause an unscheduled interruption of OWNER’s operations, immediately re-establish satisfactory operation for OWNER.
5. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of OWNER’s facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by CONTRACTOR if, in ENGINEER’s opinion, CONTRACTOR did not comply with requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in performing the Work and complying with applicable permits, Laws, and Regulations.
6. Shutdowns shall be in accordance with Table 01 14 16-B of this Section. Work requiring service interruptions for tie-ins shall be performed during scheduled shutdowns.
7. Temporary, short-term shutdowns of smaller conduits (including piping and ducting), equipment, and systems may not be included in Table 01 14 16-B. Coordinate requirements for such shutdowns with ENGINEER and OWNER. Where necessary, obtain ENGINEER’s interpretation or clarification before proceeding.

B. Shutdowns of Electrical Systems:

1. Comply with Laws and Regulations, including the National Electric Code.
2. CONTRACTOR shall lock out and tag circuit breakers and switches operated by OWNER and shall verify that affected cables and wires are de-energized to ground potential before shutdown Work is started.
3. Upon completion of shutdown Work, remove the locks and tags and notify ENGINEER that facilities are available for use.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL

- A. In addition to requirements of this Section, comply with Section 01 73 29, Cutting and Patching, and Section 01 73 24, Connections to Existing Facilities, and other Contract Documents applicable to Work associated with shutdowns, tie-ins, temporary pumping (where applicable), and similar work.

3.2 DETAILED SHUTDOWN REQUIREMENTS

- A. Shutdown A:
 1. General:
 - a. Affected Equipment Operating Prior to Shutdown: Existing Pumps No. 1 & 2, Pump Station Influent Channels and Wet Wells
 - b. Equipment Operating During Shutdown: In accordance with Table 01 14 16-B of this Section.
 - c. Equipment Out of Service During Shutdown: In accordance with Table 01 14 16-B of this Section.
 - d. Impact on Other Equipment and Processes: Temporary Pumping to isolate Pump Station from the Collection System.
 - e. Procedure: Install new Force Main Connection and establish temporary pumping system.
 2. Temporary Pumping: Provide temporary pumping system, including controls, as follows:
 - a. Purpose: To convey Pump Station flows for duration of the shutdown.
 - b. System Capacity: 6500 gallons per minute.
 - c. Fluid Pumped: Unscreened wastewater in a combined sewer system .
 - d. Controls: Provide a complete control system to maintain the liquid level in the suction chamber.
 - e. Suction Location: Influent Manhole.
 - f. Discharge Location: Force Main Connection.
 3. Prior to Shutdown:
 - a. Obtain ENGINEER's acceptance of proposed shutdown planning submittal and shutdown notification submittal.

- b. Bring necessary piping, couplings, valves, equipment, and appurtenances to the work areas.
- c. Assist OWNER in preparing to take equipment, tanks, basins, and conduits (including piping and ducting) temporarily out of service.
- d. Coordinate other tie-ins to be performed simultaneously.
- e. Install, check, and test the temporary pumping system.
- 4. During Shutdown:
 - a. Place temporary pumping system into operation.
 - b. Refer to staging items in Paragraph 1.4.
 - c. With OWNER, return equipment and system to operation.
- 5. Following Shutdown:
 - a. Verify functionality of equipment and systems.
 - b. Verify operation of new equipment and systems, and verify that joints in conduits (including piping and ducting) are watertight or gastight as applicable.
 - c. Repair joints that are not watertight or gastight, as applicable.
 - d. Remove temporary pumping system and appurtenances.

3.3 SCHEDULES

- A. The schedules indicated below, attached following this Section's "End of Section" designation, are part of this Specifications Section:
 - 1. Table 01 14 16-A, Schedule of Tie-ins.
 - 2. Table 01 14 16-B, Schedule of Shutdowns.

+ + END OF SECTION + +

TABLE 01 14 16-A SCHEDULE OF TIE-INS					
Tie-In No.	New Line Size and Service	Existing (Connecting) Line Size & Service	Tie-In Building/Location	Construction Stage	Remarks
1	20-inch Pump Discharge Header	20-inch Force Main	Dry Well	II	
2	Pump No. 4	20-inch Force Main	Dry Well	III	
3	Pump Nos. 2 & 3	20-inch Force Main	Dry Well	IV	
4	Pump No. 1	20-inch Force Main	Dry Well	V	
5					
6					

**TABLE 01 14 16-B
SCHEDULE OF SHUTDOWNS**

Shut-down No.	Process Equipment and Service Lines Out-of-Service During Shutdown	Process Equipment In Operation During Shutdown	Tie-In Nos.	Maximum Duration
A	Wet Well and Influent Channels	n/a	1	30 days (Stage II)
B	Wet Well No. 3	Existing Pumps No. 1 & 2		
C	Wet Well No. 2	Existing Pump No. 1 / New Pump No. 4		
D	Wet Well No. 1	New Pumps No. 2, 3 & 4		

SECTION 01 21 00

ALLOWANCES

PART 1 – GENERAL

1.1 SCOPE

- A. Scope:
 - 1. This Section includes administrative and procedural requirements governing the following types of allowances:
 - a. Cash allowances.
 - b. Contingency allowances.
- B. Authorization of Allowances:
 - 1. Work that will be paid under an allowance will be authorized in OWNER's written instruction to CONTRACTOR using the form included with this Section or other written allowance authorization issued by OWNER.
 - 2. Do not perform Work under an allowance without written authorization of OWNER.

1.2 CASH ALLOWANCES

- A. General:
 - 1. Cash allowances are stipulated amounts for anticipated purchase of materials or equipment.
 - 2. In addition to this Section, refer to the General Conditions, as may be modified by the Supplementary Conditions; and individual Specification Sections for CONTRACTOR's costs to be covered by cash allowances, and CONTRACTOR's costs, including overhead and profit, to be included elsewhere in the Contract Price.
- B. Timing:
 - 1. At earliest practical date after the Contract Times commence running, notify ENGINEER of date when final selection and purchase of each material or equipment item described by a cash allowance must be completed to avoid delaying the Work.
- C. Selection of Materials or Equipment Included in Cash Allowance:
 - 1. Consult with ENGINEER in selecting Suppliers and obtain proposals for price and time from selected suppliers. Submit proposals to ENGINEER along with recommendations relevant to furnishing and installing products covered in the cash allowance.
 - 2. Purchase materials or equipment from Suppliers selected by ENGINEER.

D. Documentation:

1. Proposals:

- a. Prior to selection of Supplier by ENGINEER, submit proposals from prospective suppliers as indicated in above.
- b. For each allowance, submit to ENGINEER a Change Proposal to adjust Contract Price for difference between specified cash allowance amount and actual cost. Prepare Change Proposals in accordance with the General Conditions and Supplementary Conditions and Section 01 26 00, Contract Modification Procedures, except that payment within limit of a cash allowance shall exclude cost of bond and insurance premiums.

2. When applying for payment for materials or equipment furnished under a cash allowance, submit with the Application for Payment invoices or delivery slips as evidence of actual costs and quantities of materials or equipment furnished and used in fulfilling each cash allowance.

- E. Prepare unused materials or equipment, furnished under a cash allowance, for storage by OWNER, when not economically practical to return for credit. Deliver to storage space at the Site designated by OWNER.

1.3 CONTINGENCY ALLOWANCE

- A. Contingency allowances are stipulated amounts available as reserve for sole use by OWNER to cover unanticipated costs.
- B. When authorization of Work under contingency allowance is contemplated by OWNER for a defined scope, submit Change Proposal to ENGINEER. Prepare Change Proposal in accordance with the General Conditions and Supplementary Conditions and Section 01 26 00, Contract Modification Procedures, except that payments within limit of contingency allowance shall exclude cost of bond and insurance premiums.

1.4 SCHEDULE OF ALLOWANCES

A. Cash Allowances:

B. Contingency Allowances:

1. Schedule of Contingency Allowances: Include the following allowances for use in accordance with OWNER's instructions:

Contract and Bid/Payment Item No.	Allowance Name	Include Contingency Allowance Amount Of

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ATTACHMENTS

- A. The documents listed below, and attached following this Section’s “End of Section” designation, are part of this Specification Section.
 - 1. Allowance Authorization Form (one page).

+ + END OF SECTION + +

ALLOWANCE AUTHORIZATION

Project: _____	Authorization Number: _____
_____	From: _____
To: _____	Date: _____
_____	Engineer Project No.: _____
Re: _____	Contract For: _____

You are authorized to perform the following item(s) of Work and to adjust the Contract allowance amount accordingly:

1. [Allowance Title] / [Title of Change]:

THIS IS NOT A CHANGE ORDER AND DOES NOT INCREASE OR DECREASE THE CONTRACT PRICE

Original Allowance	\$ _____
Allowance Expenditures prior to this Authorization	\$ _____
Allowance Balance prior to this Authorization	\$ _____
Allowance will be decreased by this Authorization.....	\$ _____
New Allowance Balance	\$ _____

RECOMMENDED BY

ARCADIS U.S., Inc.
Engineer

By _____ Date _____

OWNER APPROVAL

Owner

By _____ Date _____

CONTRACTOR ACCEPTANCE

Contractor

By _____ Date _____

☐ Attachments

Copies: ☐ Owner ☐ Contractor ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ File

SECTION 01 22 13

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
1. Items listed starting in Article 1.4 of this Section refer to and are the same pay items listed in the Bid Form and constitute all pay items for completing the Work.
 2. No direct or separate payment will be made for providing miscellaneous temporary or accessory works, facility services, layout surveys, Project signs, sanitary requirements, testing, safety provisions and safety devices, submittals and record drawings, water supplies, power and fuel, maintenance of traffic, removal of waste, security, coordination with OWNER's operations, information technology (including hardware, software, and services) required during construction, commissioning where specified, bonds, insurance, or other requirements of the General Conditions, Supplementary Conditions, Division 01 Specifications, and other requirements of the Contract Documents.
 3. Compensation for all services, items, materials, and equipment shall be included in prices stipulated for lump sum and unit price pay items listed in this Section and included in the Contract.
- B. Each lump sum and unit price, as bid, shall include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

- A. ENGINEER's estimated quantities for items of Unit Price Work, as included in the Contract, are approximate only and are included solely for purpose of comparing Bids and pricing. OWNER does not expressly or by implication agree that nature of materials encountered below the ground surface or actual quantities of material encountered or required will correspond with the quantities included in the Contract at the time of award and reserves the right to increase or decrease quantities, and to eliminate quantities, as OWNER may deem necessary.
- B. CONTRACTOR and OWNER will not be entitled to adjustment in unit prices as a result of change in estimated quantity and agree to accept the unit prices accepted in the Bid as complete and total compensation for additions or deletions caused by changes or alterations in the Unit Price Work directed by OWNER.

1.3 RELATED PROVISIONS

- A. Payments to CONTRACTOR: Refer to General Conditions, Supplementary Conditions, Agreement, and Section 01 29 76, Progress Payment Procedures.
- B. Changes in Contract Price: Refer to General Conditions, Supplementary Conditions, and Section 01 26 00, Contract Modification Procedures.
- C. Schedule of Values: Refer to General Conditions, Supplementary Conditions, and Section 01 29 73, Schedule of Values.

1.4 CONTRACT NO. 1 – GENERAL CONSTRUCTION

- A. Item 1 – General Construction:
 - 1. Measurement and Payment: Lump sum payment for Item 1 will be full compensation for completing the Work, as shown or indicated under Division 01 through Division 49. Additional work items that CONTRACTOR may be ordered by ENGINEER to perform are described below.
- B. Item 2 – Unit Price Items:
 - 1. 2A and 2B – Concrete Crack Repair (Type 2 and Type 3):
 - a. Description:
 - i. Work under this item shall consist of all labor, equipment and incidentals necessary to provide for concrete crack repair ordered in writing by the ENGINEER.
 - ii. Perform concrete crack repair as directed by and in accordance with all requirements of Section 03930, Concrete Repair and Rehabilitation.
 - b. Measurement for Payment:
 - i. The quantity of concrete crack repair measured for payment shall be the actual length of concrete crack repair provided.
 - c. Payment:
 - i. Payment for each concrete crack repair Item 2A and 2B shall be at the Contract unit price bid per linear foot of concrete crack repair actually provided, as follows:
 - 1) Item 2A: Actual linear footage of non-structural crack repairs. (Type 2)
 - 2) Item 2B, Actual linear footage of structural crack repairs. (Type 3)
 - 2. Items 2C and 2D– Concrete Surface Repair:
 - a. Description:
 - i. Work under this item shall consist of all labor, equipment, and incidentals necessary to provide for concrete surface repair ordered in writing by the ENGINEER.
 - ii. Perform concrete surface repair as directed by and in accordance with the requirements of Section 03930, Concrete Repair and

Rehabilitation.

- b. Measurement for Payment:
 - i. The quantity of concrete surface repair measured for payment shall be the actual area of concrete surface repair provided.
 - c. Payment:
 - i. Payment for each concrete surface repair Item 2C and 2D shall be at the Contract unit price bid per square foot of concrete surface repair actually provided, as follows:
 - 1) Item 2C: Actual square footage of patching of voids without rebar repair to a depth of 4-in. or less.
 - 2) Item 2D: Actual square footage of patching of voids with rebar repair to a depth of less 4-in. or less.
3. Item 2E – Exposed Aggregate Repair:
- a. Description:
 - i. Work under this item shall consist of all labor, equipment and incidentals necessary to provide for exposed aggregate repair ordered in writing by the ENGINEER.
 - ii. Perform exposed aggregate repair as directed by and in accordance with all requirements of Section 03930, Concrete Repair and Rehabilitation.
 - b. Measurement for Payment:
 - i. The quantity of exposed aggregate repair measured for payment shall be the actual area of exposed aggregate repair provided.
 - c. Payment:
 - i. Payment for each exposed aggregate repair Item 2E shall be at the Contract unit price bid per square foot of exposed aggregate repair actually provided.

C. Item 3 – Allowance Items:

- 1. 3A – Provision of New Electrical Service
 - a. Measurement: Under this item, the CONTRACTOR shall furnish all labor, material and equipment required for the installation of a new electric service at the Beardsley Pump Station as described in Section 26 05 45, Utility Services for Electrical Systems.
 - b. Payment: The total amount paid to the CONTRACTOR shall be full compensation for actual work performed to install new electric service up to and including the new meter and shall include all United Illuminating Co. charges and incidentals, including excavation and backfill, required for installation.
- 2. 3B – Provision of New Natural Gas Service
 - a. Measurement: Under this item, the CONTRACTOR shall furnish all labor, material and equipment required for the installation of a new high pressure natural gas service at the Beardsley Pump Station.
 - b. Payment: The total amount paid to the CONTRACTOR shall be full compensation for actual work performed to install new natural gas service up to and including the new meter and shall include all Southern

Connecticut Gas charges and incidentals, including excavation and backfill, required for installation.

D. Bid Alternate Item A – Wet Well Aluminum Cover System:

1. Description:
 - a. Bid Alternate Item A includes all labor, equipment and incidentals necessary to furnish and install a new aluminum cover system in the Wet Well. Included in this Bid Alternate is Type 4 Exposed Aggregate Repair and Epoxy Coating beneath the new aluminum cover system.
 - b. CONTRACTOR shall include the cost of completing all work under Bid Alternate Item A in the bid. Bid Alternate Item A may be added to this Contract at the OWNER's discretion. All provisions of the Contract Documents will apply to work included in Bid Alternate Item A, if added to the Contract.
2. Payment:
 - a. Lump sum payment for Bid Alternate Item A will be full compensation for completing the Work required for the wet well aluminum cover system shown on the Contract Drawings and as specified. This Work includes but is not limited to all labor, equipment, fees, and other related costs necessary to execute the Work.

E. Bid Alternate Item B – Odor Control System:

1. Description:
 - a. Bid Alternate Item B includes all labor, equipment and incidentals necessary to furnish, install, test, and start-up a new odor control system for the Beardsley Pump Station.
 - b. CONTRACTOR shall include the cost of completing all work under Bid Alternate Item B in the bid. Bid Alternate Item B may be added to this Contract at the OWNER's discretion. All provisions of the Contract Documents will apply to work included in Bid Alternate Item B, if added to the Contract.
2. Payment:
 - a. Lump sum payment for Bid Alternate Item B will be full compensation for completing the Work required for the odor control system shown on the Contract Drawings and as specified. This Work includes but is not limited to all labor, equipment, fees, and other related costs necessary to execute the Work.

F. Bid Alternate Item C – Channel Grinders:

1. Description:
 - a. Bid Alternate Item C includes all labor, equipment and incidentals necessary to furnish, install, test, and start-up (2) channel grinders in the influent channels of the Beardsley Pump Station.
 - b. CONTRACTOR shall include the cost of completing all work under Bid Alternate Item C in the bid. Bid Alternate Item C may be added to this

Contract at the OWNER's discretion. All provisions of the Contract Documents will apply to work included in Bid Alternate Item C, if added to the Contract.

2. Payment:
 - a. Lump sum payment for Bid Alternate Item C will be full compensation for completing the Work required for the channel grinders shown on the Contract Drawings and as specified. This Work includes but is not limited to all labor, equipment, fees, and other related costs necessary to execute the Work.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope: Section includes:
 - 1. Administrative and procedural requirements for selecting materials and equipment for the Project.
 - 2. Procedural requirements for substitutions of materials and equipment.
 - 3. Procedural requirements for substitute construction methods or procedures, when construction methods or procedures are specified.
- B. A proposed substitute will not be accepted for review if:
 - 1. Approval would require changes in design concept or a substantial revision of the Contract Documents.
 - 2. Approval would delay completion of the Work or the work of other contractors.
 - 3. Substitution request is indicated or implied on a Shop Drawing or other submittal, or on a request for interpretation or clarification, and is not accompanied by CONTRACTOR's formal and complete request for substitution.
- C. If proposed substitute is not approved, CONTRACTOR shall provide the specified materials, equipment, method, or procedure, as applicable.
- D. Approval of a substitute does not relieve CONTRACTOR from requirement for submitting Shop Drawings and other submittals in accordance with the Contract Documents.
- E. ENGINEER and OWNER have the right to rely upon the completeness and accuracy of the information included in CONTRACTOR's request for approval of a substitute, and CONTRACTOR accepts full responsibility for the completeness and accuracy thereof.
- F. When approved substitute is defective or fail to perform in accordance with the Contract Documents, responsibility for remedying the defect or failure resides solely with CONTRACTOR and Supplier.

1.2 SUBSTITUTE MATERIALS AND EQUIPMENT

- A. Requests for approval of substitute items of materials or equipment will be considered within a period of 60 days after the Effective Date of the Contract. After the end of specified period, substitution requests will be considered only in case of

unavailability of a specified item of material or equipment or other conditions beyond CONTRACTOR's control.

B. Procedure:

1. Submit requests for substitution in accordance with requirements for furnishing submittals, as indicated in Section 01 33 00, Submittal Procedures.
2. Submit separate request for each proposed substitute.
3. Submit request for substitution using forms attached to this Section. Complete all information requested on each form, and enclose with the forms supplementary information as required. In addition to requirements of the General Conditions and information required on substitution request forms, include with each substitute request the following:
 - a. Identification of the materials and equipment (as applicable), including manufacturer's name and address.
 - b. Manufacturer's literature with description of the materials and equipment, performance and test data, and reference standards with which materials and equipment comply.
 - c. Samples, when appropriate.
 - d. Name and address of similar projects on which the materials and equipment were used, date of installation, and names and contact information (including telephone number) for the facility operations and maintenance manager.

1.3 SUBSTITUTE CONSTRUCTION METHODS OR PROCEDURES

- A. The provisions of the General Conditions, as may be modified by the Supplementary Conditions, regarding substitute items of materials and equipment are hereby extended to apply to substitute construction methods or procedures.

B. Procedure:

1. Submit requests for substitution in accordance with requirements for furnishing submittals, as indicated in Section 01 33 00, Submittal Procedures.
2. Submit separate request for each proposed substitute.
3. Submit request for substitution using forms attached to this Section. Complete all information requested on each form, and enclose with the forms supplementary information as required. In addition to requirements of the General Conditions and information required on substitution request forms, include with each substitute request the following:
 - a. Detailed description of proposed method or procedure.
 - b. Itemized comparison of the proposed substitution with the specified method or procedure.
 - c. Drawings illustrating method or procedure.
 - d. Other data required by ENGINEER to establish that proposed substitution is equivalent to specified method or procedure.

1.4 CONTRACTOR'S REPRESENTATIONS

- A. In submitting request for substitution, CONTRACTOR represents that:
1. CONTRACTOR has read and fully understands the provisions regarding substitutes as indicated in the General Conditions, as may be modified by the Supplementary Conditions.
 2. Substitution request is complete and includes all information required by the Contract Documents.
 3. CONTRACTOR certifications required by the General Conditions, as may be modified by the Supplementary Conditions, are valid and made with CONTRACTOR's full knowledge, information, and belief.
 4. CONTRACTOR will provide the same or better guarantees or warranties for proposed substitute as for the specified materials, equipment, methods, or procedures, as applicable.
 5. CONTRACTOR waives all Claims for additional costs or extension of time related to proposed substitute that subsequently may become apparent.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ATTACHMENTS

- A. The documents listed below, and attached following this Section's "End of Section" designation, are part of this Specification Section.
1. Substitution Request Form (two pages).
 2. Product Substitution Checklist (one page).

+ + END OF SECTION + +

SUBSTITUTION REQUEST

Project: _____ Substitution Request Number: _____

From: _____
To: _____ Date: _____

Engineer Project. No. _____
Re: _____ Contract For: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitute: _____
Manufacturer: _____ Address: _____ Phone: _____
Trade Name: _____ Model No.: _____
Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 1 to 4 years old ☐ 5 to 10 years old ☐ More than 10 years old

Differences between proposed substitute and specified item: _____

☐ Point-by-point comparative data attached — REQUIRED BY THE CONTRACT DOCUMENTS

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Engineer: _____
Address: _____ Owner: _____
_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

Savings to Owner for accepting substitute: _____ (\$ _____)
(attach detailed, itemized estimate)

Proposed substitute changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.
(clarify whether change is to Substantial Completion, Milestone, or time for readiness for final payment)

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

SUBSTITUTION REQUEST

(Continued)

☐ Substitute product, method, or procedure is subject to payment of licensing fee or royalty (check if “yes” and attach information)

☐ Substitute product, method, or procedure is patented or copyrighted (check if “yes” and attach information)

The undersigned certifies:

- Representations in the General Conditions and in Section 01 25 00, Substitution Procedures, regarding substitutions are valid.
- Same or better warranty and guarantee will be furnished for proposed substitution as for specified item.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitute will have no adverse effect on other trades and will not affect or delay Progress Schedule.
- Cost data as stated above is complete. Claims for additional costs or time related to accepted substitution which may subsequently become apparent are waived.
- Proposed substitute does not affect dimensions and functional clearances.
- Payment will be made for Engineer’s review and changes, if any, to the design and Contract Documents, and construction costs caused by the substitute.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: ☐

ENGINEER’S REVIEW AND ACCEPTANCE (OR NON-ACCEPTANCE) WILL BE DOCUMENTED IN A FIELD ORDER OR CHANGE ORDER, AS APPROPRIATE. _____

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ Engineer
☐ Other:

PRODUCT SUBSTITUTION CHECKLIST

Date: _____ Re: _____

Engineer Proj No.: _____ Manufacturer's Project No.: _____

Filing No.: _____ Contract For: _____

Item Equivalence:

- ☐ Is the submitted item equivalent to the specified item? _____
- ☐ Does it serve the same function? _____
- ☐ Does it have the same dimensions? _____
- ☐ Does it have the same appearance? _____
- ☐ Will it last as long? _____
- ☐ Does it comply with the same codes, and standards and performance requirements? _____
- ☐ Has the item been used locally, and where are the projects? _____

- ☐ Has a problem occurred with the item, and what was the remedy? _____

Effect on the Project:

- ☐ Will the substitute affect other aspects of the construction? _____
- ☐ Are any details affected and are changes required? _____
- ☐ What is the cost of the changes? _____
- ☐ Who pays for the required changes? _____
- ☐ Are Contract Times affected? _____

Effect on the Warranty:

- ☐ How does the proposed warranty differ from the specified warranty? _____

- ☐ Does the manufacturer have a track record of standing behind the warranty? _____

SECTION 01 26 00

CONTRACT MODIFICATION PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope.
 - 1. This Section expands upon provisions of the General Conditions, as may be modified by the Supplementary Conditions, and includes:
 - a. Requests for interpretation.
 - b. Written clarifications.
 - c. Minor changes in the Work and Field Orders.
 - d. Work Change Directives.
 - e. Proposal Requests.
 - f. Change Proposals.
 - g. Change Orders.
- B. Submit Contract modification documents to ENGINEER, addressed to the contact person and contact information indicated in Section 01 33 00, Submittal Procedures, and in accordance with Section 01 31 26, Electronic Communication Protocols.
- C. Retain at CONTRACTOR's office and at the Site complete copy of each Contract modification document and related documents, and ENGINEER's response.

1.2 REQUESTS FOR INTERPRETATION

- A. General.
 - 1. Transmit written requests for interpretation to ENGINEER. CONTRACTOR and OWNER may prepare and transmit requests for interpretation.
 - 2. Prepare and transmit request for interpretation to obtain clarifications or interpretations of the Contract Documents. Report conflicts, errors, ambiguities, and discrepancies in the Contract Documents by requesting an interpretation.
 - 3. Do not transmit request for interpretation when other form of communication is appropriate, such as CONTRACTOR's submittals, requests for approvals of substitutes, notices, ordinary correspondence, or other form of communication. Improperly prepared or inappropriate requests for interpretation will be returned without response or action by ENGINEER.
 - 4. Do not submit request for interpretation or clarification when:
 - a. answer may be obtained by observations at the Site; or
 - b. required information is clearly indicated in the Contract Documents; or

- c. required information is included in industry standards referenced in the Contract Documents or Supplier's instructions that are consistent with the Contract Documents; or
 - d. are reasonably inferable from any of foregoing.
- 5. CONTRACTOR shall have sole financial responsibility for requests for interpretations or clarifications that are submitted late, out of sequence, or that are unnecessary.

B. Procedure.

- 1. Transmit requests for interpretation in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Include with each request for interpretation a separate letter of transmittal.
- 2. ENGINEER will provide timely review of requests for interpretation. Allow sufficient time for review and response.
- 3. ENGINEER will maintain log of requests for interpretation. Upon request, copy of log will be transmitted to requestor.
- 4. ENGINEER's response to requests for interpretation will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each response to a request for interpretation will include a separate letter of transmittal.
- 5. ENGINEER's written response to each request for interpretation will be distributed to:
 - a. CONTRACTOR.
 - b. OWNER.
 - c. Resident Project Representative (RPR).
 - d. ENGINEER.
- 6. If ENGINEER requests additional information to make an interpretation, entity requesting the interpretation shall transmit the information requested within ten days, unless ENGINEER allows additional time, via correspondence referring to request for interpretation number.
- 7. Interpretations that One or Both Parties Believes Entails a Change to the Contract:
 - a. If CONTRACTOR or OWNER believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of ENGINEER's interpretation, so advise ENGINEER in writing before proceeding with the Work associated with the request for interpretation.
 - b. If, after this initial communication, either OWNER or CONTRACTOR believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.

C. Preparation of Requests for Interpretation:

- 1. Prepare each request for interpretation on the "Request for Interpretation" form included with this Section, or other form acceptable to ENGINEER.

2. Number each request for interpretation as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number. Example: First request for interpretation on the general contract for project titled, "Contract A15" would be, "RFI No. A15-GC-001".
3. In space provided on form, describe the interpretation requested. Provide additional sheets as necessary. Include text and sketches as required in sufficient detail to describe the the need for an interpretation.
4. When applicable, request for interpretation shall include CONTRACTOR's recommended resolution.

1.3 WRITTEN CLARIFICATIONS

A. General:

1. Written clarifications, when required, will be initiated and issued by ENGINEER.
2. Written clarifications do not change the Contract Price or Contract Times, and do not alter the Contract Documents.
3. Written clarifications will be issued as correspondence or using clarification notice form, with additional information as required.

B. Procedure.

1. ENGINEER's written clarifications will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section.
2. Each written clarification will be distributed to:
 - a. CONTRACTOR.
 - b. OWNER.
 - c. Resident Project Representative (RPR).
 - d. ENGINEER.
3. Written Clarifications that One or Both Parties Believes Entails a Change to the Contract:
 - a. If CONTRACTOR or OWNER believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of ENGINEER's written clarification, so advise ENGINEER in writing before proceeding with the Work associated with the written clarification.
 - b. If, after this initial communication, either OWNER or CONTRACTOR believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.
4. If ENGINEER's written clarification is unclear, prepare and transmit a request for interpretation.

1.4 MINOR CHANGES IN THE WORK AND FIELD ORDERS

A. General:

1. Field Orders, when required, will be initiated and issued by ENGINEER.
 2. Field Orders authorize minor variations in the Work but do not change the Contract Price or Contract Times.
 3. Field Orders will be in the form of Engineers Joint Contract Documents Committee document EJCDC® C-942, "Field Order".
 4. ENGINEER will maintain a log of Field Orders issued.
- B. Procedure.
1. Field Orders will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Field Order will include a separate letter of transmittal.
 2. Each Field Order will be distributed to:
 - a. CONTRACTOR.
 - b. OWNER.
 - c. Resident Project Representative (RPR).
 - d. ENGINEER.
 3. Field Orders that One or Both Parties Believes Entails a Change to the Contract Price or Contract Times:
 - a. If CONTRACTOR or OWNER believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of a Field Order, so advise ENGINEER in writing before proceeding with the Work associated with the Field Order.
 - b. If, after this initial communication, CONTRACTOR believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.
 4. If the Field Order is unclear, submit request for interpretation.

1.5 WORK CHANGE DIRECTIVES

- A. General:
1. Work Change Directives, when required, order additions, deletions, or revisions to the Work.
 2. Work Change Directives do not change the Contract Price or Contract Times but are evidence that the parties to the Contract expect that the change ordered or documented by the Work Change Directive will be incorporated in subsequently issued Change Order following agreement by the parties as to the Work Change Directive's effect, if any, on the Contract Price or Contract Times..
 3. Work Change Directives will be in the form of EJCDC® C-940, "Work Change Directive".
- B. Procedure.
1. Work Change Directives signed by OWNER and ENGINEER will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Work Change Directive will

- include a separate letter of transmittal. CONTRACTOR shall print three originals of Work Change Directive for CONTRACTOR's signature.
2. CONTRACTOR shall promptly sign each original Work Change Directive and, within five days of receipt, return all originals to ENGINEER.
 3. Original, signed Work Change Directives will be distributed as follows:
 - a. CONTRACTOR: One original.
 - b. OWNER: One original.
 - c. ENGINEER: One original.
 4. One copy of each Work Change Directive will be distributed to:
 - a. Resident Project Representative (RPR).
 5. Documentation of Costs:
 - a. When basis of payment for Work ordered under a Work Change Directive will be paid as Cost of the Work, or when otherwise required by ENGINEER, document for the Work performed under each separate Work Change Directive, for each day, the following:
 - 1) Number and labor classifications of workers employed and hours worked.
 - 2) Construction equipment used including manufacturer, model, and year of manufacture, and number of hours such equipment was onsite and used for the Work under the Work Change Directive.
 - 3) Consumables and similar materials used.
 - 4) Receipts, bills, or invoices for and descriptions of materials and equipment incorporated into the Work.
 - 5) Invoices and labor and equipment breakdowns for Subcontractors and Suppliers.
 - 6) Other information required by OWNER or ENGINEER,
 - b. Submit such information in a format acceptable to ENGINEER.
 - c. Transmit such documentation to ENGINEER as a Change Proposal.

1.6 PROPOSAL REQUESTS

A. General:

1. Proposal Requests may be initiated by ENGINEER or OWNER.
2. Proposal Requests are for requesting the effect on the Contract Price and the Contract Times and other information relative to contemplated changes in the Work. Proposal Requests do not authorize changes or variations in the Work, and do not change the Contract Price or Contract Times or terms of the Contract.
3. Proposal Requests will be furnished using the "Proposal Request" form included with this Section.

B. Procedure.

1. Proposal Requests will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Proposal Requests will include a separate letter of transmittal.
2. Each signed Proposal Request will be transmitted to:

- a. CONTRACTOR.
 - b. OWNER.
 - c. Resident Project Representative (RPR).
 - d. ENGINEER.
3. Transmit request for interpretation to clarify conflicts, errors, ambiguities, and discrepancies in Proposal Request.
 4. Upon receipt of Proposal Request, CONTRACTOR shall prepare and transmit to ENGINEER a Change Proposal, in accordance with the Contract Documents, for the proposed Work described in the Proposal Request.

1.7 CHANGE PROPOSALS

A. General.

1. Prepare and transmit written Change Proposal to ENGINEER in response to each Proposal Request; or when CONTRACTOR believes a change in the Contract Price or Contract Times or other change to the terms of the Contract is required; or to appeal an initial decision by ENGINEER concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract.

B. Procedure.

1. Prepare and transmit Change Proposals within time limits indicated in the General Conditions, as may be modified by the Supplementary Conditions.
2. Transmit Change Proposals in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Include with each Change Proposal all required supporting documentation and a separate letter of transmittal.
3. ENGINEER's Review and Requests for Additional Information:
 - a. ENGINEER will review and act on each Change Proposal in accordance with, and within the time limits indicated in, the General Conditions, as may be modified by the Supplementary Conditions.
 - b. When, ENGINEER requests additional information to render a decision, submit required information within five days of receipt of ENGINEER's request, unless ENGINEER allows more time. Submit the required information via correspondence that refers to the specific Change Proposal number.
 - c. OWNER shall transmit to ENGINEER such comments, if any, that OWNER has on the Change Proposal, within 10 days of OWNER's receipt of the Change Proposal.
 - d. ENGINEER will render a written decision on the Change Proposal.
 - e. ENGINEER's response to Change Proposals will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section, the General Conditions, and the Supplementary Conditions.

4. ENGINEER's response to each Change Proposal will be distributed to:
 - a. CONTRACTOR.
 - b. OWNER.
 - c. Resident Project Representative (RPR).
 - d. ENGINEER.
 5. If Change Proposal is recommended for approval by ENGINEER and is approved by OWNER, a Change Order will be issued or, when applicable, an appropriate use of contingency allowance will be authorized by OWNER.
 6. If parties do not agree on terms for the change, OWNER or CONTRACTOR may file a Claim against the other, in accordance with the General Conditions, as may be modified by the Supplementary Conditions.
- C. Preparation of Change Proposals:
1. Each Change Proposal shall be submitted on the "Change Proposal" form included with this Section, or other form acceptable to ENGINEER.
 2. Number each Change Proposal as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number. Example: First Change Proposal for the general contract for project named "Contract A15" would be, "Change Proposal No. A15-GC-001".
 3. In space provided on Change Proposal form:
 - a. Describe scope of each proposed change. Include text and sketches on additional sheets as required to provide detail sufficient for ENGINEER's review and response. If a change item is submitted in response to Proposal Request, write in as scope, "In accordance with Proposal Request No." followed by the Proposal Request number. Submit written clarifications, if any, to scope of change.
 - b. Submit justification for each proposed change. If change is in response to proposal request, write in as justification, "In accordance with Proposal Request No." followed by the proposal request number.
 - c. List the total change in the Contract Price and Contract Times for each separate change item included in the Change Proposal.
 4. Unless otherwise directed by ENGINEER, attach to the Change Proposal detailed breakdowns of pricing (Cost of the Work and CONTRACTOR's fee) including:
 - a. List of Work tasks to accomplish the change.
 - b. For each task, labor cost breakdown including labor classification, total hours per labor classification, and hourly cost rate for each labor classification.
 - b. Construction equipment and machinery to be used, including manufacturer, model, and year of manufacture, and number of hours for each.
 - c. Detailed breakdown of cost of materials and equipment to be incorporated into the Work, including quantities, unit costs, and total cost, with Supplier's written quotations.

- d. Breakdowns of the Cost of the Work and fee for Subcontractors, including labor, construction equipment and machinery, and materials and equipment incorporated into the Work, other costs, and Subcontractor fees (e.g., overhead and profit).
- e. Breakdown of other costs eligible, in accordance with the General Conditions and the Supplementary Conditions under “Cost of the Work” provisions.
- f. Other information required by ENGINEER.
- g. CONTRACTOR’s fees applied to eligible CONTRACTOR costs and eligible Subcontractor costs.

1.8 CHANGE ORDERS

A. General:

- 1. Change Orders will be recommended by ENGINEER (when required by the General Conditions), and will be signed by OWNER and CONTRACTOR, to authorize additions, deletions, or revisions to the Work, or changes to the Contract Price or Contract Times.
- 2. Change Orders will be in the form of EJCDC® C-941, “Change Order”.

B. Procedure.

- 1. Change Orders for signature by CONTRACTOR will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Change Order will include a separate letter of transmittal. CONTRACTOR shall print three originals of Change Order for CONTRACTOR’s signature.
- 2. CONTRACTOR shall promptly sign each original Change Order and, within five days of receipt, return all originals to ENGINEER.
- 3. ENGINEER will sign each original Change Order and forward them to OWNER.
- 4. After approval and signature by OWNER, original Change Orders will be distributed as indicated below.
- 5. Original, signed Change Orders will be distributed as follows:
 - a. CONTRACTOR: One original.
 - b. OWNER: One original.
 - c. ENGINEER: One original.
- 6. One copy of each Change Order will be distributed to:
 - a. Resident Project Representative (RPR).

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ATTACHMENTS

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

1. Request for Interpretation form (one page).
2. Proposal Request form (one page).
3. Change Proposal form (one page).

+ + END OF SECTION + +

REQUEST FOR INTERPRETATION

Owner: _____

Project Name: _____

Contractor: _____ RFI No. _____

Date Transmitted: _____ Date Received: _____

Date Response Requested: _____ Date Response Transmitted: _____

Subject: _____

Specification Section and Paragraph: _____

Drawing References: _____

INTERPRETATION REQUESTED:

Signature: _____

Date: _____

ENGINEER'S RESPONSE:

Signature: _____

Date:

PROPOSAL REQUEST

Owner: _____

Project Name: _____

Proposal Request No.: _____ Date: _____

Contract Name and No.: _____

Contractor: _____

Other Contracts Involved in Proposed Change: _____

TO CONTRACTOR: Please submit a complete Change Proposal for the proposed modifications described below. If the associated Change Proposal is approved, a Change Order or allowance authorization will be issued to authorize adjustment so the scope of the Work. This Proposal Request is not a Change Order, Work Change Directive, Field Order, or an authorization to proceed with the proposed Work described below.

SCOPE OF PROPOSED WORK:

1. *Item:*
2. *Item:*
3. *Item:*

Proposal requested by: _____

Signature _____ of _____ Requestor:

CHANGE PROPOSAL

Owner: _____

Project Name: _____

Change Proposal No.: _____ Date: _____

Submitted in Response to Proposal Request No.: _____

Contract Name and No.: _____

Contractor: _____

Subject: _____

The following changes to the Contract are proposed:

SCOPE OF WORK: *(attach and list supporting information as required)*

1. Item:

2. Item:

JUSTIFICATION:

1. Item:

2. Item:

CHANGES IN CONTRACT PRICE AND CONTRACT TIMES:

We propose that the Contract Price and Contract Times be changed as follows:

For Contract Price, attach detailed cost breakdowns for Contractor and Subcontractors, Supplier quotations, and other information required.

For the Contract Times, state increase, decrease, or no change to Contract Times for Substantial Completion, readiness for final payment, and Milestones, if any. If increase or decrease, state specific number of days for changes to the Contract Times.

Description	Amount	Contract Times (days)	
		Substantial	Final
1. Item	\$0.00	0	0
2. Item	\$0.00	0	0
Total This Change Proposal	\$0.00	0	0

Changes _____ to _____ Milestones, _____ if _____ any:

Contractor represents that supporting data attached to this Change Proposal are accurate and complete. The requested time or price adjustment indicated in this Change Proposal is the entire adjustment to which Contractor believes it is entitled as a result of the proposed change(s) indicated herein.

Change Proposal by: _____

Signature

of

Proposer:

SECTION 01 29 73

SCHEDULE OF VALUES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall prepare and submit to ENGINEER for acceptance a Schedule of Values that allocates cost to each item of the Work. Schedule of Value list of line items shall correspond to each aspect of the Work, establishing in detail the portion of the Contract Price allocated to each major component of the Work.
2. Upon request of ENGINEER, support values with data that substantiate their correctness.
3. Submit preliminary Schedule of Values to ENGINEER for initial review. CONTRACTOR shall incorporate ENGINEER's comments into the Schedule of Values and resubmit to ENGINEER. ENGINEER may require corrections and re-submittals until Schedule of Values is acceptable.
4. Schedule of Values may be used as a basis for negotiating price of changes, if any, in the Work.

1.2 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Submit to ENGINEER Schedule of Values in the form and quantity required in Section 01 33 00, Submittal Procedures, and in accordance with Section 01 31 26, Electronic Communication Protocols.
2. Content of Schedule of Values submittals shall be in accordance with Article 1.3 of this Section.
3. Timing of Submittals:
 - a. Submit preliminary Schedule of Values within time limit indicated in the General Conditions.
 - b. Submittal of the Schedule of Values for acceptance by ENGINEER shall be in accordance with the General Conditions. ENGINEER will not accept Applications for Payment without an acceptable Schedule of Values.
 - c. When required by ENGINEER, promptly submit updated Schedule of Values to include cost breakdowns for changes in the Contract Price.

1.3 SCHEDULE OF VALUES FORMAT AND CONTENT

A. Organization and Major Elements of Schedule of Values

1. Prepare Schedule of Values on the “progress estimate” or “continuation sheets”, as applicable, of the Application for Payment form indicated in Section 01 29 76, Progress Payment Procedures.
 2. Include in Schedule of Values itemized list of Work for each major work area included in the Work, for each payment item specified in Section 01 22 13, Measurement and Payment.
 3. Organization in Accordance with Specification Sections:
 - a. Within each work area, organize the Schedule of Values by the various Specifications Section numbers and titles included in the Contract Documents.
 - b. Label each row in the Schedule of Values with the appropriate Specifications Section number. Include an amount for each row in the Schedule of Values.
 - c. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
 4. Include in Schedule of Values unit price payment items with their associated quantity. Provide in the Schedule of Values detailed breakdown of unit prices when required by ENGINEER.
- B. Requirements for preliminary Schedule of Values and Schedule of Values are:
1. Subcontracted Work:
 - a. Schedule of Values shall show division of Work between CONTRACTOR and Subcontractors.
 - b. Line items for Work to be done by Subcontractor shall include the word, “(SUBCONTRACTED)”.
 2. Apportionment between Materials and Equipment, and Installation:
 - a. Schedule of Values shall include breakdown of costs for materials and equipment, installation, and other costs used in preparing the Bid by CONTRACTOR and each Subcontractor.
 - b. List purchase and delivery costs for materials and equipment for which CONTRACTOR may apply for payment as stored materials.
 3. Sum of individual values shown on the Schedule of Values shall equal the total of associated payment item. Sum of payment item totals in the Schedule of Values shall equal the Contract Price.
 4. Overhead and Profit: Include in each line item a directly proportional amount of CONTRACTOR’s overhead and profit. Do not include overhead and profit as separate item(s).
 5. Include separate line item for each allowance, and for each unit price item.
 6. Bonds and Insurance Costs: Include line item for bonds and insurance in amount not exceeding 2.0 percent of the Contract Price. This amount may be applied for in the first Application for Payment.
 7. Include relevant items for the General Conditions, permits (when applicable), construction Progress Schedule, and other items required by ENGINEER. Include such items in Applications for Payment on payment schedule acceptable to ENGINEER

8. Line items for Site maintenance such as dust control, snow removal, compliance with storm water pollution prevention plans and permits, spill prevention control and countermeasures plans, and for construction photographic documentation; temporary utilities and temporary facilities, field offices, temporary controls, field engineering, and similar Work shall be included in the Schedule of Values and proportioned in Applications for Payment throughout duration of the Work.
9. Mobilization and Demobilization:
 - a. Include separate line items under each appropriate payment item for mobilization and demobilization. Document for ENGINEER the activities included in mobilization and demobilization line items.
 - b. Mobilization will be limited to 2.0 percent of the Contract Price, and will be paid in four payments, each of 25 percent of total amount for mobilization.
 - c. Demobilization shall be not less than 1.0 percent of the Contract Price and shall be included with the Application for Payment following Substantial Completion, or other schedule acceptable to ENGINEER.
10. Costs for Shop Drawings, Samples, and other submittals; operations and maintenance manuals; field testing; and training of operations and maintenance personnel shall be as follows, unless otherwise accepted by ENGINEER:
 - a. Up to eight percent of cost (including all associated overhead and profit) of each equipment item, exclusive of transportation and installation costs associated with that item, may be allocated to preparation of Shop Drawings, Samples, and other submittals and may be included in the Application for Payment following ENGINEER's approval of Shop Drawings (and acceptance of other submittals, as applicable) required for fabricating or purchasing for that item for the Work.
 - b. Up to three percent of total cost of each item (including all associated overhead and profit), including materials and equipment, and installation, may be apportioned to testing and included in the Application for Payment following ENGINEER's acceptance of the associated written field testing report(s).
 - c. Up to a total of four percent of equipment cost (including all associated overhead and profit), exclusive of transportation and installation costs, may be apportioned to operations and maintenance manuals and training of operations and maintenance personnel, which may be included in the Application for Payment following completion of training for that item.
11. Project Record Documents:
 - a. Include in the Schedule of Values a line item with appropriate value for Project record documents.
 - b. If adequate record documents are maintained, up to 50 percent of the value of the record documents line item will be eligible for payment, spread evenly over those progress payments in which construction at the Site is performed.
 - c. Remainder of Project record documents line item will be eligible for payment when complete record documents are submitted in accordance

with the Contract Documents. If record documents submitted are unsatisfactory to ENGINEER, amount may be reduced via set-offs in accordance with the Contract Documents.

12. Schedule of Values shall include an itemized list of Work by work area, as applicable, for Work included in Section 01 14 16, Coordination with Owner's Operations.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 29 76

PROGRESS PAYMENT PROCEDURES

PART 1 – GENERAL

1.1 PROGRESS PAYMENTS

A. Scope:

1. CONTRACTOR's requests for payment shall be in accordance with the Agreement, General Conditions and Supplementary Conditions, and the Specifications.
2. Form: Applications for Payment shall be in the form of Engineers Joint Contract Documents Committee (EJCDC) document EJCDC® C-620, "Contractor's Application for Payment", 2013 edition or later.

B. Procedure:

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

C. Each request for progress payment shall include:

1. Completed Application for Payment form, including summary/signature page, progress estimate sheets, and stored materials summary. Progress estimate sheets shall have the same level of detail as the Schedule of Values.
2. Documentation for Stored Materials and Equipment:
 - a. For materials and equipment not incorporated in the Work but suitably stored, submit documentation in accordance with the General Conditions and Supplementary Conditions.
 - b. Legibly indicate on invoice or bill of sale the specific materials or equipment included in the payment request and corresponding bid/payment item number for each.
3. Certified Payrolls for Contractor and Subcontractors.
4. Listing of Subcontractors and Suppliers:

- a. In accordance with the General Conditions, submit not less than monthly updated listing of all Subcontractors and Suppliers known to CONTRACTOR, whether or not such entities have a contract directly with CONTRACTOR.
 - b. Submit complete information using the form attached to this Section.
- 5. Allowance Work:
 - a. For payment requests that include payment for Work under an allowance, include with the progress payment request copy of OWNER's authorization of the associated allowance Work, in accordance with Section 01 21 00, Allowances.
- 6. Partial Release or Reduction of Retainage:
 - a. For each Application for Payment where CONTRACTOR requests partial release or reduction of retainage in any amount (other than request for final payment), submit with associated progress payment request consent of surety to partial release or reduction of retainage, duly completed by CONTRACTOR and surety.
 - b. Acceptable form includes AIA® G707A™, "Consent of Surety to Reduction in or Partial Release of Retainage", 1994 or later edition, or other form acceptable to OWNER.
 - c. For payment requests that include reduction in or payment of retainage in an amount greater than that required by the Contract Documents, obtain OWNER's concurrence for partial release or reduction in retainage prior to submitting such Application for Payment.

D. Final Payment:

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

1.2 PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Observation of Stored Materials and Equipment Prior to Application for Payment:

- 1. General:
 - a. Prior to materials or equipment suitably stored but not yet incorporated into the Work can be eligible for payment, ENGINEER or Resident Project Representative (RPR) shall visit the storage location and verify the extent, condition, and storage environment of the stored items.
 - b. When the same material or equipment item is stored for more than two months, such visits to storage location shall be not less than once every two months.
- 2. Cost Responsibility for Observations:
 - a. When storage location is less than 20 miles from the Site or less than 20 miles from ENGINEER's office, CONTRACTOR is not responsible for reimbursing OWNER for cost of ENGINEER's time and expenses for observing stored materials and equipment.

- b. When storage location is more than 20 miles from the Site and more than 20 miles from ENGINEER's office, CONTRACTOR shall reimburse OWNER, via a set-off under the Contract Documents, for cost of ENGINEER's time and expenses, including travel time, to visit the storage location and observe the stored materials and equipment.
- 3. When materials or equipment are stored in a bonded warehouse, CONTRACTOR may submit affidavit of delivery to the warehouse (affidavit signed by warehouse operator and CONTRACTOR) in lieu of ENGINEER's or RPR's first visit to the storage location. Affidavit shall specifically indicate the following relative to the stored items:
 - a. Extent and quantity of stored items.
 - b. Condition of stored items and packaging (if items are stored in wrap or crates).
 - c. Conditions of storage environment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ATTACHMENTS

- A. The forms listed below, following this Section's "End of Section" designation, are part of this Specification Section:
 - 1. List of Subcontractors and Suppliers form (two pages).

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE++

LIST OF SUBCONTRACTORS AND SUPPLIERS

Owner: _____

Project Name: _____

Contractor: _____ Date: _____

Contract Designation: _____

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

SUBCONTRACTORS

1. Subcontractor Name:

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

2. Subcontractor Name:

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

3. Subcontractor Name:

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

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

SUPPLIERS

1. Supplier Name:

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

2. Supplier Name:

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

3. Supplier Name:

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

SECTION 01 31 13

PROJECT COORDINATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall coordinate the Work, including testing agencies whether hired by CONTRACTOR, OWNER, or others; Subcontractors, Suppliers, and others with whom coordination is necessary, in accordance with the General Conditions, Supplementary Conditions, and this Section, to perform the Work within the Contract Times and in accordance with the Contract Documents.

B. Coordination:

1. In accordance with the General Conditions as may be modified by the Supplementary Conditions, CONTRACTOR shall cooperate with and coordinate the Work with utility owners, utility service companies, OWNER's and facility manager's employees working at the Site, and other entities working at the Site, in accordance with Section 01 11 13, Summary of Work.
2. CONTRACTOR will not be responsible or liable for damage unless damage is through negligence of CONTRACTOR, or Subcontractors, Supplier, or other entity employed by CONTRACTOR.
3. Attend and participate in all project coordination and progress meetings, and report on the progress of the Work and compliance with the Progress Schedule.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE++

SECTION 01 31 19.13

PRE-CONSTRUCTION CONFERENCE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. A pre-construction conference will be held for the Project.
 - 2. CONTRACTOR shall attend the conference prepared to discuss all items on the pre-construction conference agenda.
 - 3. ENGINEER will distribute an agenda, preside at conference, and prepare and distribute minutes to all conference participants and others as requested.
- B. Purpose of Pre-construction Conference:
 - 1. Purpose of conference is to designate responsible personnel, establish working relationships, discuss preliminary schedules submitted by CONTRACTOR, and review administrative and procedural requirements for the Project.
 - 2. Matters requiring coordination will be discussed and procedures for handling such matters will be established.
 - 3. Unless otherwise indicated in the Contract Documents or otherwise agreed to by the entities involved, Site mobilization meeting will be part of the pre-construction conference.

1.2 PREPARATION FOR PRE-CONSTRUCTION CONFERENCE

- A. Date, Time, and Location:
 - 1. Conference will be held after execution of the Contract and before Work starts at the Site.
 - 2. ENGINEER will establish the date, time, and location of conference and notify the interested and involved entities.
- B. Submittals Required Prior to Pre-construction Conference:
 - 1. Not less than three days prior to pre-construction conference, submit the following preliminary schedules in accordance with the General Conditions and other requirements of the Contract Documents:
 - a. Preliminary Progress Schedule.
 - b. Preliminary Schedule of Submittals.
 - c. Preliminary Schedule of Values.
 - d. Listing of identity and general scope of Work or supply (as applicable) of planned Subcontractors and Suppliers. Indicate extent of each Subcontract proposed and overall percentage of Contract Price to be subcontracted.

- C. CONTRACTOR shall furnish information required and contribute appropriate items for discussion at the pre-construction conference.
- D. Handouts for Pre-Construction Conference:
 - 1. CONTRACTOR shall bring to the conference the following, with sufficient number of copies for each attendee:
 - a. Preliminary Progress Schedule, as submitted to ENGINEER.
 - b. Preliminary Schedule of Submittals, as submitted to ENGINEER.
 - c. Preliminary Schedule of Values, as submitted to ENGINEER.
 - d. Listing of identity and general scope of Work or supply of planned Subcontractors and Suppliers.
 - e. List of emergency contact information.

1.3 REQUIRED ATTENDEES

- A. Representative of each entity attending the conference shall be authorized to act on that entity's behalf.
- B. Contractor Attendance: Conference shall be attended by CONTRACTOR's:
 - 1. Project manager.
 - 2. Site superintendent
 - 3. Project managers for major Subcontractors, and major equipment Suppliers as CONTRACTOR deems appropriate.
- C. Other attendees will be representatives of:
 - 1. OWNER.
 - 2. ENGINEER.
 - 3. Resident Project Representative (RPR), if available.
 - 4. Authorities having jurisdiction over the Work, if available.
 - 5. Utility owners, as applicable.
 - 6. Others as requested by OWNER, CONTRACTOR, or ENGINEER.

1.4 AGENDA

- A. Preliminary Agenda: Be prepared to discuss in detail the topics indicated below. Revisions, if any, to the agenda below will be furnished to required attendees prior to the pre-construction conference.
 - 1. Procedural and Administrative:
 - a. Personnel and Teams:
 - 1) Designation of roles and personnel.
 - 2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
 - 3) Subcontractors and Suppliers in attendance.
 - 4) Authorities having jurisdiction.
 - b. Procedures for communications and correspondence, including electronic communication protocols.

- c. Copies of the Contract Documents and availability.
- d. Subcontractors and Suppliers.
 - 1) Lists of proposed Subcontractors and Suppliers.
- e. The Work and Scheduling:
 - 1) General scope of the Work.
 - 2) Contract Times, including Milestones (if any).
 - 3) Phasing and sequencing.
 - 4) Preliminary Progress Schedule.
 - 5) Critical path activities.
- f. Safety:
 - 1) Responsibility for safety.
 - 2) Contractor's safety representative.
 - 3) Emergency procedures and accident reporting.
 - 4) Emergency contact information.
 - 5) Confined space entry permits.
 - 6) Hazardous materials communication program.
 - 7) Impact of Project on public safety.
- g. Permits.
- h. Review of insurance requirements and insurance claims.
- i. Coordination:
 - 1) Project coordination, and coordination among contractors.
 - 2) Construction coordinator.
 - 3) Coordination with Owner's operations.
 - 4) Progress meetings.
 - 1) Preliminary Schedule of Submittals.
 - 2) Procedures for furnishing and processing submittals.
 - 3) Work not eligible for payment until submittals are approved or accepted (as required).
 - 4) Construction photographic documentation.
- k. Substitutes and "Or-Equals":
 - 1) Product options.
 - 2) Procedures for proposing "or-equals".
 - 3) Procedures for proposing substitutes.
- l. Contract Modification Procedures
 - 1) Requests for interpretation
 - 2) Written clarifications
 - 3) Field Orders
 - 4) Proposal Requests
 - 5) Change Proposals
 - 6) Work Change Directives.
 - 7) Change Orders.
 - 8) Procedure for Claims and dispute resolution
- m. Payment:
 - 1) Owner's Project financing and funding, as applicable.
 - 2) Owner's tax-exempt status.
 - 3) Preliminary Schedule of Values

- 4) Procedures for measuring for payment.
 - 5) Retainage.
 - 6) Progress payment procedures.
 - 7) Prevailing wage rates and payrolls.
- n. Testing and inspections, including notification requirements.
- o. Disposal of demolition materials.
- p. Record documents.
- q. Preliminary Discussion of Contract Closeout:
 - 1) Procedures for Substantial Completion.
 - 2) Contract closeout requirements.
 - 3) Correction period.
 - 4) Duration of bonds and insurance.
- 2. Site Mobilization (if not covered in a separate meeting):
 - a. Working hours and overtime.
 - b. Field offices, storage trailers, and staging areas.
 - c. Temporary facilities.
 - d. Temporary utilities and limitations on utility consumption (where applicable).
 - e. Utility company coordination (if not done as a separate meeting).
 - f. Access to Site, access roads, and parking for construction vehicles.
 - g. Maintenance and protection of traffic.
 - h. Use of Site and premises.
 - i. Protection of property.
 - j. Security.
 - k. Temporary controls, such as sediment and erosion controls, noise controls, dust control, storm water controls, and other such measures.
 - l. Site barriers and temporary fencing.
 - m. Storage of materials and equipment.
 - n.. Reference points and benchmarks; surveys and layouts.
 - o. Site maintenance during the Project.
 - p. Cleaning and removal of trash and debris.
 - q. Restoration.
- 3. General discussion and questions.
- 4. Next meeting.
- 5. Site visit, if required.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 31 19.23

PROGRESS MEETINGS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Progress meetings will be held throughout the Project. CONTRACTOR shall attend each progress meeting prepared to discuss in detail all items on the agenda.
 - 2. ENGINEER will preside at progress meetings and will prepare and distribute minutes of progress meetings to all meeting participants and others as requested.

1.2 PREPARATION FOR PROGRESS MEETINGS

- A. Date and Time:
 - 1. Regular Meetings: Every month on a day and time agreeable to OWNER, ENGINEER, and CONTRACTOR.
 - 2. Other Meetings: As required.
- B. Location:
 - 1. On Site or other location mutually agreed upon by OWNER, CONTRACTOR, and ENGINEER.
- D. Handouts:
 - 1. CONTRACTOR shall bring to each progress meeting not less than five copies of each of the following:
 - a. List of Work accomplished since the previous progress meeting.
 - b. Up-to-date Progress Schedule.
 - c. Up-to-date Schedule of Submittals.
 - d. Detailed “look-ahead” schedule of Work planned through the next progress meeting, with specific starting and ending dates for each activity, including shutdowns, deliveries of important materials and equipment, Milestones (if any), and important activities affecting the OWNER, Project, and Site.
 - e. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.

1.3 REQUIRED ATTENDANCE

- A. Representatives present for each entity shall be authorized to act on that entity's behalf.
- B. Required Attendees:
 - 1. CONTRACTOR:
 - a. Project manager.
 - b. Site superintendent.
 - c. Safety representative.
 - d. When needed for the discussion of a particular agenda item, representatives of Subcontractors and Suppliers shall attend meetings.
 - 2. ENGINEER:
 - a. Project manager or designated representative
 - b. Resident Project Representative (if any).
 - c. Others as required by ENGINEER.
 - 3. OWNER's representative(s), as required.
 - 4. Others, as appropriate.

1.4 AGENDA

- A. Preliminary Agenda: Be prepared to discuss in detail the topics listed below. Revised agenda, if any, will be furnished to CONTRACTOR prior to first progress meeting. Progress meeting agenda may be modified by ENGINEER during the Project as required.
 - 1. Review, comment, and amendment (if required) of minutes of previous progress meeting.
 - 2. Review of progress since the previous progress meeting.
 - 3. Planned progress through next progress meeting.
 - 4. Review of Progress Schedule
 - a. Contract Times, including Milestones (if any)
 - b. Critical path.
 - c. Schedules for fabrication and delivery of materials and equipment.
 - d. Corrective measures, if required.
 - 5. Submittals:
 - a. Review status of critical submittals.
 - b. Review revisions to Schedule of Submittals.
 - 6. Contract Modifications
 - a. Requests for interpretation
 - b. Written clarifications
 - c. Field Orders
 - d. Proposal Requests
 - e. Change Proposals
 - f. Work Change Directives.
 - g. Change Orders.
 - h. Claims.

7. Applications for progress payments.
8. Problems, conflicts, and observations.
9. Quality standards, testing, and inspections.
10. Coordination between parties.
11. Site management issues, including access, security, maintenance and protection of traffic, maintenance, cleaning, and other Site issues.
12. Safety.
13. Permits.
14. Construction photographic documentation.
15. Record documents status.
16. Punch list status, as applicable.
17. Other business.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

+ + NO TEXT ON THIS PAGE+ +

SECTION 01 31 26

ELECTRONIC COMMUNICATION PROTOCOLS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section establishes the procedures with which the parties will comply regarding transmission or exchange of electronic data for the Project.
2. CONTRACTOR shall provide labor, materials, tools, equipment, services, utilities, and incidentals shown, specified, and required for complying with this Section throughout the Project.
3. This Section does not supersede the General Conditions, as may be modified by the Supplementary Conditions, regarding transmitting of the Contract Documents to CONTRACTOR after the Effective Date of the Contract.
4. In addition to the requirements of this Section, comply with requirements for exchange of electronic data in the following:
 - a. Section 01 32 16, Progress Schedule.
 - b. Section 01 32 33, Photographic Documentation.
 - c. Section 01 33 00, Submittal Procedures.
 - d. Section 01 78 39, Project Record Documents.

B. Coordination:

1. CONTRACTOR shall require all Subcontractors and Suppliers to comply with the electronic communication protocols established in this Section.

C. Related Sections:

1. Section 01 32 16, Progress Schedule.
2. Section 01 32 33, Photographic Documentation.
3. Section 01 33 00, Submittal Procedures.
4. Section 01 78 39, Project Record Documents.

1.2 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:

1. “Electronic data” means information, communications, drawings, or designs created or stored for the Project in electronic or digital form.
2. “Confidential information” means electronic data that the transmitting party has designated as confidential and clearly marked with an indication such as “Confidential”, “Business Proprietary”, or similar designation.
3. “Written” or “in writing” means any and all communications, including without limitation a notice, consent, or interpretation, prepared and sent to

an address provided in the Contract Documents or otherwise agreed upon by the parties and ENGINEER using a transmission method set forth in this Section that allows the recipient to print or store the communication. Communications transmitted electronically are presumed received when sent in conformance with this Paragraph 1.2.A.3.

1.3 TRANSMISSION OF ELECTRONIC DATA

- A. Transmission of electronic data constitutes a warrant by the transmitting party to the receiving party that the transmitting party is one or more of the following:
 - 1. The copyright owner of the electronic data.
 - 2. Has permission from the copyright owner to transmit the electronic data for its use on the Project.
 - 3. Is authorized to transmit confidential information.
- B. Receiving party agrees to keep confidential information confidential and not to disclose it to another person except to (1) its employees, (2) those who need to know the content of the confidential information to perform services or construction solely and exclusively for the Project, or (3) its consultants, contractors, Subcontractors, and Suppliers whose contracts include similar restrictions on the use of electronic data and confidential information.
- C. Transmitting party does not convey any right in the electronic data or in the software used to generate or transmit such data. Receiving party may not use electronic data unless permission to do so is provided in the Contract Documents, or in a separate license.
- D. Unless otherwise granted in a separate license, receiving party's use, modification, or further transmission of electronic data, as provided the Contract Documents, is specifically limited to the design and construction of the Project in accordance with this Section, and nothing contained in this Section conveys any other right to use the electronic data for any other purpose.
- E. To the fullest extent permitted by Laws and Regulations, receiving party shall indemnify and defend the transmitting party from and against all claims arising from or related to receiving party's modification to, or unlicensed use of, electronic data.
- F. Means of Transmitting Electronic Data: Unless otherwise indicated in Table 01 31 26-A of this Section or elsewhere in the Contract Documents, transmission of electronic data for the Project will generally be via:
 - 1. E-mail and files attached to e-mail. Maintain e-mail system capable of transmitting and receiving files not less than 20 megabytes (MB) file size.

1.4 ELECTRONIC DATA PROTOCOLS

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

TABLE 01 31 26-A
ELECTRONIC DATA PROTOCOL TABLE (E-MAIL ATTACHMENTS)

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

- B. Key to Electronic Data Protocol Table:

Data Format:

EM .msg, .htm, .txt, .rtf, e-mail text

W .docx, Microsoft® Word 2007 or later
EX .xlsx, Microsoft® Excel 2007 or later
PDF .pdf. Portable Document Format
DWG .dwg. Autodesk AutoCAD 2013 drawing.

Transmitting Party:

O OWNER
C CONTRACTOR
E ENGINEER

Transmission Method:

EM Via e-mail
EMA As an attachment to an e-mail transmission
CD Delivered via compact disc
PW Posted to Project website
FTP FTP transfer to receiving FTP server

Receiving Party:

O OWNER
C CONTRACTOR
E ENGINEER

Permitted Uses:

S Store and view only
R Reproduce and distribute
I Integrate (incorporate additional electronic data without
modifying data received)
M Modify as required to fulfill obligations for the Project

Notes:

- (1) Modifications by ENGINEER to CONTRACTOR's submittals and requests for interpretations are limited to printing out, marking-up, and adding comment sheets.
- (2) May be distributed only to affected Subcontractors and Suppliers. Print out, sign document, and return executed printed copy originals to ENGINEER.
- (3) Submit printed Applications for Payment with original ("wet") signatures.
- (4) Submit notices, including Claims, in accordance with the notice provisions of the General Conditions, as may be modified by the Supplementary Conditions.

- (5) Submit record drawings in native CAD format indicated when CONTRACTOR has executed ENGINEER's standard agreement for release of electronic files. In addition, always submit record drawings as a PDF file. Comply with requirements of Section 01 78 39, Project Record Documents.
- (6) For operation and maintenance data, also submit printed copies as required by Section 01 78 23, Operations and Maintenance Data.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 32 16

PROGRESS SCHEDULE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall prepare and submit Progress Schedules and related documents in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section, unless otherwise accepted by ENGINEER.
2. Maintain and update Progress Schedules and related documents.
3. Progress Schedule shall be resource-loaded CPM Progress Schedule.
4. ENGINEER's acceptance of the Progress Schedule or related documents, and comments or opinions concerning activities in the Progress Schedule and related documents shall not control CONTRACTOR's independent judgment concerning means, methods, techniques, sequences and procedures of construction, unless the associated means, method, technique, sequence, or procedure is directed by the Contract Documents. CONTRACTOR is solely responsible for complying with the Contract Times.

B. Use of Float:

1. Float belongs to the Project and may be used by OWNER or CONTRACTOR to accommodate changes in the Work, or to mitigate the effect of events that delay performance or compliance with the Contract Times.
2. Changes or delays that influence Activities that have float and that do not extend the Critical Path are not justification for an extension of the Contract Times.

C. Factors Affecting the Progress Schedule:

1. In preparing the Progress Schedule, take into consideration submittal requirements and submittal review times, time for fabricating and delivering materials and equipment, source quality control (including shop testing) and field quality control (including testing at the Site), Subcontractors' work, availability and abilities of workers, availability of construction equipment, weather conditions, restrictions in operations at the Site and coordination with OWNER's operations, and other factors that have the potential to affect completion of the Work within the Contract Times.
2. Comply with sequencing requirements indicated in the following:
 - a. Section 01 11 13, Summary of Work.
 - b. Section 01 14 16, Coordination with Owner's Operations.

1.2 DEFINITIONS

- A. The following terms are defined for this Section and supplement the terms defined in the General Conditions and Supplementary Conditions:
1. Activity: An element of the construction work that has the following specific characteristics: consumes time, consumes resources, has a definable start and finish, is assignable, and is measurable.
 2. Constraint: An imposed date on the Progress Schedule or an imposed time between Activities. The Contract Times are Constraints.
 3. CPM Progress Schedule: Computerized Progress Schedule in Critical Path Method (CPM) format which accounts for the entire Work, defines the interrelationships between elements of the Work, reflects the uncompleted Work, and indicates the sequence with which the Work has been completed, indicates the sequence in which uncompleted Work will be completed, and indicates the duration of each Activity.
 4. Critical Path: The continuous chain of Activities with the longest duration for completion within the Contract Times.
 5. Early Start: The earliest possible date an Activity can start according to the assigned relationships among Activities.
 6. Early Finish: The earliest date an Activity can finish according to the assigned relationships among the Activities.
 7. Late Finish: The latest date an Activity can finish without extending the Contract Times.
 8. Late Start: The latest date an Activity can start without extending the Contract Times.
 9. Float: The time difference between the calculated duration of the Activity chain and the Critical Path.
 10. Total Float: The total number of days that an Activity (or chain of Activities) can be delayed without affecting the Contract Times.
 11. Network Diagram: A time-scaled logic diagram depicting the durations and relationships of the Activities.
 12. Work Areas, Area, or System: A logical breakdown of the Project elements or a group of Activities which, when collectively assembled, are readily identifiable on the Project (for example: yard piping, a structure or building, a treatment process, or other logical grouping).

1.3 QUALITY ASSURANCE

- A. Qualifications:
1. Progress Schedule Preparer:
 - a. CONTRACTOR shall retain services of a scheduling consultant or shall self-prepare and maintain the Progress Schedule using qualified employee with experience in scheduling, and experienced with the scheduling software required for the Project, and experience serving as Progress Schedule preparer on construction projects of similar type, size, and scope to this Project.

- b. Progress Schedule preparer shall have not less than five years experience using the schedule software required on construction projects of similar type, size, and scope as the Project.
- c. Prior to engaging a scheduling consultant or using a qualified employee, submit to ENGINEER the following:
 - 1) Name and address of proposed Progress Schedule preparer and the names of personnel who will be assigned to scheduling the Project.
 - 2) Information sufficient to demonstrate that proposed Progress Schedule preparer and scheduling personnel to be assigned to the Project possess qualifications complying with this Section. For each person assigned, submit list of similar type, size, contract value of projects, names and contact information of engineer or architect and owner.
- d. Engineer's Review of Qualifications:
 - 1) ENGINEER will respond to CONTRACTOR whether proposed scheduling personnel are acceptable within seven days after ENGINEER's receipt of complete qualifications.
 - 2) If qualifications are not acceptable, submit qualifications of acceptable personnel within ten days of receipt of ENGINEER's non-acceptance.
 - 3) ENGINEER's acceptance or non-acceptance of qualifications does not release CONTRACTOR from its obligations under the Contract Documents.

1.4 SUBMITTALS

- A. Quantity of each submittal required and timing of submittals are in this Section.
- B. Informational Submittals: Submit the following:
 - 1. Initial Progress Schedules:
 - a. Preliminary Progress Schedule with associated Network Diagrams and narrative report.
 - b. Acceptable Progress Schedule with associated Network Diagrams and narrative report.
 - c. Preliminary resource-loaded Progress Schedule and associated reports.
 - d. Acceptable resource-loaded Progress Schedule and associated reports.
 - e. Submit each Progress Schedule submittal with letter of transmittal complying with requirements of Section 01 33 00, Submittal Procedures.
 - 2. Progress Schedule Updates.
 - a. Progress Schedule updates shall comply with requirements of this Section, and shall include updated Progress Schedule, narrative report, updated Network Diagram when relationships among Activities are changed, and updated mathematical tabulations.
 - b. Submit updated Progress Schedule prior to each progress meeting. When a Progress Schedule remains unchanged from one progress meeting to the next, submit a written statement to that effect. In addition to monthly Progress Schedule submittals, also bring to progress meeting the number of printed copies of the updated Progress Schedule indicated in Section

01 31 19.23, Progress Meetings.

3. Look-Ahead Schedules
 - a. Furnish three-week look-ahead schedule at each progress meeting.
4. Time Impact Analyses: Submit in accordance with this Section.
5. Recovery Schedule: Submit in accordance with this Section.
6. Qualifications:
 - a. Submit qualifications of Progress Schedule preparer, and other personnel that will assist Progress Schedule preparer in preparing and maintaining the Progress Schedule.

1.5 INITIAL PROGRESS SCHEDULES

- A. Type and Organization of Progress Schedules:
 1. Prepare Progress Schedule using Oracle Primavera software, unless other scheduling software is acceptable to ENGINEER.
 2. Sheet Size: 24x36, unless otherwise accepted by ENGINEER.
 3. Time Scale: Indicate first date of each work week.
 4. Activity Designations: Indicate title and related Specifications Section number.
 5. Progress Schedules shall be CPM Progress Schedules.
 6. Organization:
 - a. Indicate on the separate Schedule of Submittals dates for submitting and reviewing Shop Drawings, Samples, and other submittals.
 - b. Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
 - c. Group construction into Work Area sub-schedules (that are part of the Progress Schedule) by Activity.
 - d. Clearly indicate the Critical Path on the Progress Schedule.
 - e. Organize each Work Area sub-schedule by Specifications Section number.
- B. Preliminary Progress Schedule:
 1. Within fifteen days after the Contract Times commence running, CONTRACTOR shall submit to ENGINEER the preliminary Progress Schedule covering the entire Project, with associated Network Diagrams.
 2. Submit preliminary Progress Schedule in accordance with Section 01 31 26, Electronic Communication Protocols and Section 01 33 00, Submittal Procedures. Also submit preliminary Progress Schedule in its native format generated by the scheduling software, transmitted using the transmission method indicated in Section 01 31 26, Electronic Communication Protocols.
 3. ENGINEER will conduct a timely review of the preliminary Progress Schedule.
 4. Preliminary Progress Schedule shall comply with the Contract Documents relative to Progress Schedules, but need not be resource-loaded.
- C. Initial Acceptance of Progress Schedule:

1. Not less than ten days before submission of the first Application for Payment, a scheduling conference attended by CONTRACTOR, Progress Schedule preparer, ENGINEER, and others as appropriate will be held at the Site to review for acceptability to ENGINEER the preliminary Progress Schedule and associated Network Diagram and other reports and schedule-related documents required. Following the scheduling conference, CONTRACTOR shall have five days to make corrections and adjustments and to complete and resubmit the Progress Schedule and associated Network Diagram. No progress payment will be made to CONTRACTOR until acceptable Progress Schedule, Network Diagram, and other reports and schedule-related documents required are submitted to ENGINEER.
2. Submit acceptable Progress Schedule, together with Network Diagram, reports, and other schedule-related documents required to accompany the initial acceptable Progress Schedule, in accordance with the Submittals Article of this Section, Section 01 31 26, Electronic Communication Protocols, and Section 01 33 00, Submittal Procedures. Also submit acceptable form of Progress Schedule in its native format generated by the scheduling software, transmitted using the transmission method indicated in Section 01 31 26, Electronic Communication Protocols.
3. The Progress Schedule will be acceptable to ENGINEER if it provides an orderly progression of the Work to completion within the Contract Times, in accordance with the Contract Documents. Such acceptance will not impose on ENGINEER responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility therefor.
4. Initially-accepted Progress Schedule shall be identified as the baseline Progress Schedule.

D. Resource-Loaded Progress Schedule:

1. Not more than ten days after ENGINEER's acceptance of the Progress Schedule, submit to ENGINEER resource-loaded Progress Schedule complying with resource-loading requirements in this Section.
2. Submit of the preliminary and the acceptable resource-loaded Progress Schedules and associated reports to accompany the initial submittals of resource-loaded Progress Schedules in accordance with the Submittals Article of this Section, Section 01 31 26, Electronic Communication Protocols, and Section 01 33 00, Submittal Procedures. Also submit preliminary and acceptable form of resource--loaded Progress Schedules in its native format generated by the scheduling software, transmitted using the transmission method indicated in Section 01 31 26, Electronic Communication Protocols.
3. Resource--loaded Progress Schedules will be reviewed by ENGINEER within fourteen days of ENGINEER's receipt, and ENGINEER's comments will be transmitted to CONTRACTOR.
4. Make revisions required in accordance with ENGINEER's comments and resubmit to ENGINEER within ten days of CONTRACTOR's receipt of ENGINEER's comments.

5. Resource-loaded Progress Schedule accepted by ENGINEER shall be the basis for determining the amount of each CONTRACTOR progress payment.
- E. If the Progress Schedule reflects completion date(s) different than the Contract Times, the Contract Times are not thereby voided, nullified, or affected. The Contract Times govern. Where the Progress Schedule reflects completion date(s) that are earlier than the Contract Times, ENGINEER may accept such Progress Schedule with CONTRACTOR to specifically understand that no Change Request or Claim for additional Contract Times or additions to the Contract Price shall be brought against OWNER resulting from CONTRACTOR's failure to complete the Work by the earlier date(s) indicated on the accepted Progress Schedule.

1.6 PROGRESS SCHEDULE UPDATES

A. Updates:

1. Update the Progress Schedule not less-often than once per month. If during progress of the Work events develop that necessitate changes in the initially accepted Progress Schedule (e.g., baseline Progress Schedule), identify updated Progress Schedules sequentially as "Progress Schedule Revision 1", "2", "3", and continuing in sequence as required. Number the Progress Schedule submittals in accordance with Section 01 33 00, Submittal Procedures.
2. CONTRACTOR's Progress Schedule update shall include a narrative report in accordance with this Section. Narrative report shall include description of current progress and status of each Area of the Project, a description of progress for the period, a description of the Critical Path, a discussion of current or potential delays, Change Orders (pending and approved in since the previous Progress Schedule update), and other problems associated with maintaining the Work on schedule.
3. The update to the Progress Schedule shall be based on retained logic. Progress override logic is not allowed.
4. Required scheduling software, and schedule organization, format, and content for updated Progress Schedules are identical to that required in this Section for initial Progress Schedules.
5. Submit to ENGINEER updated Progress Schedule, together with Network Diagram (when required), reports, and other schedule-related documents required to accompany the updated Progress Schedule, in accordance with Section 01 31 26, Electronic Communication Protocols, and Section 01 33 00, Submittal Procedures. Also submit updated Progress Schedule in its native format generated by the scheduling software, transmitted using the transmission method indicated in Section 01 31 26, Electronic Communication Protocols.
6. Submit updated Network Diagrams when revisions are proposed to the logic. Indicate in the narrative report delays that have occurred since the previous updated Progress Schedule. ENGINEER will not recommend payment by OWNER of progress payments until updated Progress Schedule is received,

reviewed, and accepted by ENGINEER. Payment for out-of-sequence Work is not allowed.

B. Monthly Schedule Meeting:

1. During the month, utilizing the previous month's three-week look-ahead schedule. CONTRACTOR shall record the percent complete, start and finish dates of each scheduled Activity with the remaining duration for each Activity started but not completed, including Activities associated with procurement of materials and equipment.
2. On the same day each month, not less than one week prior to a progress meeting, CONTRACTOR, Progress Schedule preparer, ENGINEER, and others as appropriate shall meet at the Site and tour the Work to review and update the schedule and progress information gathered by CONTRACTOR during the month. After acceptance of CONTRACTOR's updated data, Progress Schedule preparer shall use this information to update the Progress Schedule.

1.7 NETWORK DIAGRAMS (PERT CHARTS)

A. Network Diagrams – General:

1. Prepare and submit Network Diagrams, as generated using the scheduling software suitable for printing on paper of the size indicated for Progress Schedules in this Section.
2. Group Network Diagrams by Area and show the order and interdependence of Activities and sequence and quantities in which the Work will be accomplished.
3. Do not use match lines on Network Diagrams. Depict interrelationships to or from Activities outside the Area shown using an Activity symbol with Activity number and description.
4. In preparing Network Diagrams, comply with the basic concept of precedence diagramming method (PDM) network scheduling to show how start of a given Activity depends on completion of preceding Activities, and how the Activity's completion may affect the start of subsequent Activities.
5. Level of schedule detail shall define the day-to-day Activities of the Work.

B. Network Diagram Content:

1. Clearly indicate the Critical Path and distinguish the Critical Path from other paths on the network.
2. Organize Network Diagrams by grouping into major Work Areas, including one for procurement of materials and equipment, and by specific Activity within each Area.
3. Logic diagrams shall include the following:
 - a. Activity number.
 - b. Activity description.
 - c. Activity duration (in work days).
 - d. Critical Path denoted.

- e. Float for each Activity.
- f. Activity or System designation.
- g. Coded Area designation.
- h. Responsibility code (e.g., CONTRACTOR, Subcontractor, trade, operation, Suppliers, or other entity responsible for accomplishing an Activity).
- i. Shift number (if more than one shift per day is to be employed).

C. Network Diagram Revisions:

- 1. General:
 - a. When conditions develop that require revisions to logic or durations of the Network Diagram associated with the initially accepted Progress Schedule (e.g., baseline Progress Schedule), identify updates to the Network Diagram in the same manner required in this Section for Progress Schedule updates.
 - b. Revision of the logic or durations from the baseline Progress Schedule initially accepted by ENGINEER shall be submitted to ENGINEER for acceptance.
 - d. Incorporate into the Progress Schedule revisions to logic or duration accepted by ENGINEER, and include in monthly narrative report both a description of revisions and listing of Activities affected by revisions.
 - e. Changes resulting from Change Orders, Work Change Directives, Field Orders, allowance authorizations, and other additions or deletions, shall be fully incorporated into the Progress Schedule and Network Diagram on the first update after the associated Change Orders, Work Change Directive, or allowance authorization is approved by OWNER, or Field Order issued by ENGINEER, including adjustments to the Contract Price (if any).
- 2. Submit revised Network Diagrams with updated Progress Schedule submittals.

1.8 RESOURCE LOADING REPORTS

A. Resource Loading:

- 1. After ENGINEER's initial acceptance of the Progress Schedule, CONTRACTOR shall assign resources for personnel labor-hours, materials, and equipment to each construction Activity within each responsibility code. Submit resource schedule reports with each updated Progress Schedule.

1.9 NARRATIVE REPORT

- A. Prepare and include with the preliminary Progress Schedule and each subsequent Progress Schedule submittal, written narrative report describing the schedule-related requirements of the Contract Documents and CONTRACTOR's plan and schedule for complying with such requirements. Narrative report shall describe the methods of sequencing and operation, resources to be employed, time frames for the construction of each of the major Systems on the Project, and time frames for

complying with the Contract Times and CONTRACTOR's interim schedule milestones.

1.10 TIME IMPACT ANALYSIS

A. Time Impact Analyses – General:

1. Prepare and submit a time impact analysis when one or more of the following occurs: a Change Proposal is prepared, a Work Change Directive is issued that will affect the Progress Schedule, or when delays are experienced. Time impact analysis shall illustrate the influence of each Change Order, Work Change Directive, allowance authorization, or delay, as applicable, on the Contract Times and schedule milestones.
2. Each time impact analysis shall include a sketch (fragnet) demonstrating how CONTRACTOR proposes to incorporate the changes in the Work or, as applicable, delays into the Progress Schedule. Fragnet shall include all logic, resource changes, and additions required as result of said Change Order, Work Change Directive, allowance authorization, or delay.
3. Fragnet shall show all CPM logic revisions for the Work associated with the Change Order, Work Change Directive, allowance authorization, or delay and its relationship to other Activities in the Network Diagram.
4. Time impact analysis shall demonstrate the time impact, based on date the Change Order, Work Change Directive, or allowance authorization was given to CONTRACTOR, or as applicable the date the delay was implemented; the status of the Work at that point in time; and the Activity duration of affected Activities. Activity duration used in the time impact analysis shall be those included in the latest update of the Progress Schedule accepted by ENGINEER, closest to the time of the start of the delay or start of the Change Order, Work Change Directive, or allowance authorization as adjusted by mutual, written agreement of the parties and ENGINEER.
5. Timing of Time Impact Analysis:
 - a. Submit each time impact analysis within fourteen days after the following, as applicable:
 - 1) Start of the delay.
 - 2) After the submittal of Change Proposal.
 - 3) After CONTRACTOR receipt of Work Change Directive.
 - b. When CONTRACTOR does not submit time impact analysis for a specific change or delay, within the specified period of time for such submittal, such non-submittal shall be construed that no extension of the Contract Times is required.

B. Evaluation by Engineer and Acceptance:

1. ENGINEER's evaluation of each time impact analysis comprised of complete information will be completed in timely manner after ENGINEER's receipt. Changes in the Contract Times will be made only by Change Order.

2. When mutual agreement is reached between the parties on effect of the change or delay in the Project, incorporate into the next Progress Schedule update the associated fragnets illustrating the influence of changes and delays.

1.11 RECOVERY SCHEDULES

A. Recovery Schedules – General:

1. When updated Progress Schedule indicates that the ability to comply with the Contract Times falls thirty or more days behind schedule, and there is no excusable delay, Change Order, or Work Change Directive to support an extension of the Contract Times, CONTRACTOR shall prepare and submit a Progress Schedule demonstrating CONTRACTOR's plan to accelerate the Work to achieve compliance with the Contract Times ("recovery schedule") for ENGINEER's acceptance.
2. Submit recovery schedule within fourteen days after submittal of updated Progress Schedule where need for recovery schedule is indicated.

B. Implementation of Recovery Schedule:

1. At no additional cost to OWNER, do one or more of the following: furnish additional labor, provide additional construction equipment, provide suitable materials, employ additional work shifts, expedite procurement of materials and equipment to be incorporated into the Work, and other measures necessary to complete the Work within the Contract Times.
2. Upon acceptance of recovery schedule by ENGINEER, incorporate recovery schedule into the next Progress Schedule update.

C. Lack of Action:

1. CONTRACTOR's refusal, failure, or neglect to take appropriate recovery action, or to submit a recovery schedule, shall constitute reasonable evidence that CONTRACTOR is not prosecuting the Work or separable part thereof with the diligence that will ensure completion within the Contract Times. Such lack of action shall constitute sufficient basis for OWNER to exercise remedies available to OWNER under the Contract Documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall retain professional photographer to perform services specified, including:
 - a. Digital photography.
 - 2. Furnish photographic documentation for the following:
 - a. Pre-construction.
 - b. Construction progress.
 - c. Final.
- B. Image Quality:
 - 1. Photographic documentation shall be in color.
 - 2. Photographic images shall be suitably staged and set up (“framed”), focused, and shall have adequate lighting to illuminate the Work and conditions that are the subject of the photograph.
 - 3. For still photographs, use camera with minimum 16.0-megapixel resolution.

1.2 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Photographer:
 - a. Photographer shall be a specialist regularly engaged in professional photography and experienced in photographing construction sites.
 - b. Upon request of ENGINEER, submit documentation of photographer having successfully performed photographic documentation for not less than five previous construction projects, each lasting not less than six months.
- B. At the Site, ENGINEER or Resident Project Representative will indicate the views to be taken and will select time at which images will be taken. Photographic subjects, views, and angles will vary with progress of the Work.

1.3 SUBMITTALS

- A. Informational Submittals: Submit the following:
 - 1. Pre-construction Photographic Documentation: Submit acceptable pre-construction photographic documentation (prints and digital files) prior to mobilizing to and disturbing the Site. Submit pre-construction photographic

documentation not later than the first Application for Payment, unless other schedule for pre-construction photographic documentation is accepted by ENGINEER.

2. Construction Progress Photographic Documentation: Submit acceptable construction progress photographic documentation (prints and digital files) not less-often than monthly. Submit with each Application for Payment, unless otherwise agreed to by ENGINEER.
 3. Qualifications Statements:
 - a. When requested by ENGINEER, prior to starting photographic documentation, submit photographer qualifications and record of experience. List of construction photography experience shall include the following for each project:
 - 1) Project name and location
 - 2) Nature of construction.
 - 3) Photographer's client with contract information.
 - 4) Approximate duration of photographer's services.
- B. Closeout Submittals: Submit the following:
1. Final Photographic Documentation: Submit acceptable final photographic documentation (prints and digital files) prior to requesting the final inspection by ENGINEER.

1.4 PHOTOGRAPHIC DOCUMENTATION – GENERAL

- A. Photographic Prints:
1. Quantity: For each photograph taken, submit to ENGINEER three prints.
 2. Print Size and Finish:
 - a. Photographs: Submit five-inch by seven-inch prints on professional-grade, nine-mil-thick, photographic paper with semi-gloss or satin finish, unless otherwise specified.
 3. Include the following information on back of each print:
 - a. Date photograph was taken.
 - b. Name of OWNER.
 - c. Name of the Site.
 - d. Project name.
 - e. Description of view shown in photograph.
 - f. Photographer name and address.
- B. Digital Files of Photographs:
1. For each photograph taken, furnish high-quality digital image in "JPG" file format compatible with Microsoft Windows 7 and higher operating systems.
 2. Image resolution shall be sufficient for clear, high-resolution prints. Minimum resolution shall be 150 dots per inch (dpi).
 3. Do not imprint date and time in the image.
 4. Electronic image filename shall describe the image; do not submit filenames automatically created by digital camera. For example, an acceptable electronic

filename would be, “Dewatering Building – Looking West at Centrifuge No. 2.jpg”.

5. Form of Digital Submittal – Images on Discs:
 - a. Submit digital files on compact discs (CD) or digital video discs (DVD).
 - b. Submit three copies of each disc with digital files of photographic images.
 - c. Include the following information on front of each disc containing photographic documentation:
 - 1) Date(s) photographs were taken.
 - 2) Name of OWNER.
 - 3) Name of the Site.
 - 4) Project name.
 - 5) Photographer name and address.

1.5 PRE-CONSTRUCTION PHOTOGRAPHIC DOCUMENTATION

- A. Pre-construction Photographic Documentation:
 1. Obtain and submit sufficient pre-construction photographic documentation to record Site conditions prior to construction. Photographs shall document work areas of all prime contracts under the Project.
 2. Pre-construction photographs are not part of required number of construction progress photographs specified in Article 1.6 of this Section.
- B. If disagreement arises on the condition of the Site and insufficient pre-construction photographic documentation was submitted prior to the disagreement, restore the grounds or area in question to extent directed by ENGINEER and to satisfaction of ENGINEER.

1.6 CONSTRUCTION PROGRESS PHOTOGRAPHIC DOCUMENTATION

- A. Progress Photographs:
 1. Take photographs not less often than once per month .
 2. Take not less than ten photographs each time photographer is at the Site.
 3. Maximum number of progress photographs required will be one hundred fifty, based on the Contract Times to Substantial Completion of the entire Project and scope of the Project on date the Contract Times commence running. Proportionately modify the extent of photographic documentation if scope of the Project or the Contract Times are modified.
 4. Obtain and submit interior and exterior photographic documentation of each structure in the work area as directed by ENGINEER at the time photographic documentation is taken.

1.7 FINAL PHOTOGRAPHIC DOCUMENTATION

- A. Final Photographs:

1. Take photographs at time and day acceptable to ENGINEER. Do not take final photographs prior to Substantial Completion of the entire Project. Work documented in final photographs shall be generally complete, including painting and finishing, furnishings, landscaping, and other visible Work
2. Take not less than thirty final photographs, based on scope of the Project at the time that the Contract Times commence running. Proportionately modify the number of final photographs if scope of Project is modified. Final photographs are not part of construction progress photographs required under Paragraph 1.6.A of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall prepare and furnish submittals in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section.
2. Provide submittals well in advance of need for the material or equipment, or procedure (as applicable), in the Work and with ample time required for delivery of materials and equipment and to implement procedures following ENGINEER's approval or acceptance of the associated submittal. Work covered by a submittal will not be included in progress payments until approval or acceptance of related submittals has been obtained in accordance with the Contract Documents.
3. CONTRACTOR is responsible for dimensions to be confirmed and corrected at the Site; quantities; information pertaining solely to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the work of all trades.
4. CONTRACTOR's signature of submittal's stamp and letter of transmittal shall be CONTRACTOR's representation that CONTRACTOR has complied with his obligations under the Contract Documents relative to that submittal. ENGINEER and OWNER shall be entitled to rely on such representations by CONTRACTOR.
5. Provisions of the General Conditions, as may be modified by the Supplementary Conditions, apply to all CONTRACTOR-furnished submittals required by the Contract Documents, regardless of whether such submittals are other than Shop Drawings or Samples.

B. Samples:

1. Submittal of Samples shall comply with the General Conditions, as may be modified by the Supplementary Conditions, this Section, and the Specifications Section in which the Sample is specified.
2. Furnish at the same time those Samples and submittals that are related to the same element of the Work or Specifications Section. ENGINEER will not review submittals without associated Samples, and will not review Samples without associated submittals.
3. Samples shall clearly illustrate functional characteristics of materials, all related parts and attachments, and full range of color, texture, pattern, and materials.

- C. Restrictions on Quantity of Submittals and Compensation of OWNER:
1. CONTRACTOR shall furnish required submittals with sufficient information and accuracy to obtain required approval or acceptance of submittal by ENGINEER with not more than the number of resubmittals indicated in the General Conditions (as may be modified by the Supplementary Conditions).
 2. Total number of CONTRACTOR's submittals shall not exceed 25 percent above the total number of first-time submittals indicated in the Schedule of Submittals initially accepted by ENGINEER in accordance with the General Conditions. ENGINEER will record ENGINEER's time for reviewing submittals of Shop Drawings, Samples, and other submittals and items requiring approval or acceptance, beyond the quantity of first-time submittals indicated in the Schedule of Submittals initially accepted by ENGINEER, and CONTRACTOR shall reimburse OWNER for ENGINEER's charges for such time.
 3. In the event that CONTRACTOR requests a substitution for a previously approved item, Contractor shall reimburse OWNER for ENGINEER's charges for such time unless the need for such substitution is beyond the control of CONTRACTOR.
 4. OWNER may impose set-offs against CONTRACTOR for the costs for which CONTRACTOR is to reimburse or compensate OWNER, in accordance with the General Conditions.

1.2 TYPES OF SUBMITTALS

- A. Submittal types are classified as follows: 1) Action Submittals, 2) Informational Submittals, 3) Closeout Submittals, and 4) Maintenance Material submittals. Type of each required submittal is designated in the respective Specifications Sections; when type of submittal is not designated in the associated Specification Section, submittal will be classified as follows:
1. Action Submittals include:
 - a. Shop Drawings.
 - b. Product data.
 - c. Delegated design submittals, which include documents prepared, sealed, and signed by a design professional retained by CONTRACTOR, Subcontractor, or Supplier for materials and equipment to be incorporated into the completed Work. Delegated design submittals do not include submittals related to temporary construction unless specified otherwise in the related Specifications Section. Delegated design submittals include: design drawings, design data including calculations, specifications, certifications, and other submittals prepared by such design professional.
 - d. Samples.
 - e. Testing plans, procedures, and testing limitations.
 2. Informational Submittals include:
 - a. Certificates.

- b. Design data not sealed and signed by a design professional retained by CONTRACTOR, Subcontractor, or Supplier.
- c. Pre-construction test and evaluation reports, such as reports on pilot testing, subsurface investigations, testing for a potential Hazardous Environmental Condition, and similar reports.
- d. Supplier instructions, including installation data, and instructions for handling, starting-up, and troubleshooting.
- e. Source quality control submittals (other than testing plans, procedures, and testing limitations), including results of shop testing.
- f. Field or Site quality control submittals (other than testing plans, procedures, and testing limitations), including results of operating and acceptability tests at the Site.
- g. Supplier reports.
- h. Sustainable design submittals (other than sustainable design closeout documentation).
- i. Special procedure submittals, including plans for shutdowns and tie-ins and other procedural submittals.
- j. Qualifications statements.
- k. Administrative submittals including:
 - 1) Progress Schedules.
 - 2) Schedules of Submittals.
 - 3) Schedules of Values.
 - 4) Photographic documentation.
 - 5) Coordination drawings, when submittal of such is required.
 - 6) Copies of permits obtained by CONTRACTOR.
 - 7) Field engineering reports, survey data, and similar information.
- 3. Closeout Submittals include:
 - a. Maintenance contracts.
 - b. Operations and maintenance data.
 - c. Bonds, such as special maintenance bonds and bonds for a specific material, equipment item, or system.
 - d. Warranty documentation.
 - e. Record documentation.
 - f. Sustainable design closeout documentation.
 - g. Software.
 - i. Keying.
- 4. Maintenance Material Submittals include:
 - a. Spare parts.
 - b. Extra stock materials.
 - c. Tools.
- 5. When type of submittal is not specified and is not included in the list above, request an interpretation from ENGINEER and ENGINEER will determine the type of submittal.

B. Not Included in this Section: Administrative and procedural requirements for following are covered elsewhere in the Contract Documents:

1. Requests for interpretations of the Contract Documents.
2. Change Orders, Work Change Directives, and Field Orders.
3. Applications for Payment
4. Reports, documentation, and permit applications required to be furnished by CONTRACTOR to authorities having jurisdiction.

1.3 REQUIREMENTS FOR SCHEDULE OF SUBMITTALS

A. Informational Submittals: Submit the following:

1. Schedule of Submittals:
 - a. Timing:
 - 1) Furnish submittal within time frames indicated in the Contract Documents.
 - 2) Submit updated Schedule of Submittals with each submittal of the updated Progress Schedule.
 - b. Content: In accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section. Requirements for content of preliminary Schedule of Submittals and subsequent submittals of the Schedule of Submittals are identical. Identify on Schedule of Submittals all submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Indicate submittals that are on the Project's critical path. Indicate the following for each submittal:
 - 1) Date by which submittal will be received by ENGINEER.
 - 2) Whether submittal will be for a substitution or "or-equal". Procedures for requesting approval of substitutes and "or-equals" are specified in the General Conditions, Section 01 25 00, Substitution Procedures, and Section 01 62 00, Product Options (for "or-equals").
 - 3) Date by which ENGINEER's response is required. Not less than fourteen days shall be allowed for ENGINEER's review, starting upon ENGINEER's actual receipt of each submittal. Allow increased time for large or complex submittals.
 - 4) For submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of other contractors, if any.
 - c. Prepare Schedule of Submittals using same software, and in same format, specified for Progress Schedules in Section 01 32 16, Progress Schedule.
 - d. Coordinate Schedule of Submittals with the Progress Schedule.
 - e. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate submittals on the Project's critical path, or that that places extraordinary demands on ENGINEER for time and resources, is unacceptable. Do not include submittals not required by the Contract Documents.
 - f. In preparing Schedule of Submittals:
 - 1) Considering the nature and complexity of each submittal, allow sufficient time for review and revision.

- 2) Reasonable time shall be allowed for: ENGINEER's review and processing of submittals, for submittals to be revised and resubmitted, and for returning submittals to CONTRACTOR.
- 3) Identify and accordingly schedule submittals that are expected to have long anticipated review times.

1.4 PROCEDURE FOR SUBMITTALS

- A. Submittal Identification System: Use the following submittal identification system, consisting of submittal number and review cycle number.
1. Submittal Number: Shall be separate and unique number correlating to each individual submittal required. Assign submittal numbers as follows:
 - a. First part of submittal number shall be the applicable Specifications Section number, followed by a hyphen.
 - b. Second part of submittal number shall be a three-digit number (sequentially numbered from 001 through 999) assigned to each separate and unique submittal furnished under the associated Specifications Section.
 - c. Typical submittal number for the third submittal furnished for Section 40 05 19, Ductile Iron Process Pipe, would be "40 05 19-003".
 2. Review Cycle Number: Shall be a letter designation indicating the initial submittal or re-submittal associated with each submittal number:
 - a. "A" = Initial (first) submittal.
 - b. "B" = Second submittal (e.g., first re-submittal).
 - c. "C" = Third submittal (e.g., second re-submittal).
 3. Examples:

Example Description	Submittal Identification	
	Submittal No.	Review Cycle
Initial (first) review cycle of the third submittal provided under Section 40 05 19, Ductile Iron Process Pipe	40 05 19-003-	A
Second review cycle (first re-submittal) of third submittal provided under Section 40 05 19, Ductile Iron Process Pipe	40 05 19-003-	B

- B. Letter of Transmittal for Submittals:
1. Furnish separate letter of transmittal with each submittal. Each submittal shall be for one Specifications Section.
 2. At beginning of each letter of transmittal, include a reference heading indicating: CONTRACTOR's name, OWNER's name, Project name, Contract designation, transmittal number, and submittal number.
 3. For submittals with proposed deviations from requirements of the Contract Documents, letter of transmittal shall specifically describe each proposed variation.

- C. Contractor's Review and Stamp:

1. Contractor's Review: Before transmitting submittals to ENGINEER, review submittals to:
 - a. ensure proper coordination of the Work;
 - b. determine that each submittal is in accordance with CONTRACTOR's desires;
 - c. verify that submittal contains sufficient information for ENGINEER to determine compliance with the Contract Documents.
2. Incomplete or inadequate submittals will be returned without review.
3. Contractor's Stamp and Signature:
 - a. Each submittal furnished shall bear CONTRACTOR's stamp of approval and signature, as evidence that submittal has been reviewed by CONTRACTOR and verified as complete and in accordance with the Contract Documents.
 - b. Submittals without CONTRACTOR's stamp and signature will be returned without review. Signatures that appear to be computer-generated will be regarded as unsigned and the associated submittal will be returned without review.
 - c. CONTRACTOR's stamp shall contain the following:

"Project Name: _____

Contractor's Name: _____

Contract Designation: _____

Date: _____

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

Submittal Title: _____

Specifications:

Section: _____

Page No.: _____

Paragraph No.: _____

Drawing No.: _____ of _____

Location of Work: _____

Submittal No. and Review Cycle: _____

Coordinated by Contractor with Submittal Nos.: _____

I hereby certify that the Contractor has satisfied Contractor's obligations under the Contract Documents relative to Contractor's review and approval of this submittal.

Approved for Contractor by: _____"

D. Submittal Marking and Organization:

1. Mark on each page of submittal and each individual component submitted with submittal number and applicable Specifications paragraph.
 2. Arrange submittal information in same order as requirements are written in the associated Specifications Section.
 3. Each Shop Drawing sheet shall have title block with complete identifying information satisfactory to ENGINEER.
 4. Package together submittals for the same Specifications Section. Do not furnish required information piecemeal.
- E. Format of Submittal and Recipients:
1. Action Submittals and Informational Submittals: Furnish in accordance with Table 01 33 00-A, except that submittals of Samples shall be as specified elsewhere in this Section:

**TABLE 01 33 00-A: SUBMITTAL CONTACTS
AND REQUIRED FORMAT**

	Address for Deliveries	Contact Person	E-mail Address	Format*	No. of Printed Copies
a.	Engineer: ARADIS U.S., Inc.	TBD		E	Zero
b.	Resident Project Representative: At the Site.	TBC		E & P	One
c.					
* Format: E = Electronic files; P = Printed copies. TBD = To Be Determined					

2. Samples:
 - a. Securely label or tag Samples with submittal identification number. Label or tag shall include clear space at least four inches by four inches in size for affixing ENGINEER's review stamp. Label or tag shall not cover, conceal, or alter appearance or features of Sample. Label or tag shall not be separated from the Sample.
 - b. Submit quantity of Samples required in Specifications. If quantity of Samples is not indicated in the associated Specifications Section, furnish not less than two identical Samples of each item required for ENGINEER's approval. Samples will not be returned to CONTRACTOR. If CONTRACTOR requires Sample(s) for CONTRACTOR's use, so advise ENGINEER in writing and furnish additional Sample(s). CONTRACTOR is responsible for furnishing, shipping, and transporting additional Samples.
 - c. Deliver one Sample to the Site. Deliver balance of Samples to ENGINEER at address indicated in Table 01 33 00-A, unless otherwise directed by ENGINEER.
3. Closeout Submittals:
 - a. Furnish the following Closeout Submittals in accordance with Table 01 33 00-A: maintenance contracts; bonds for specific materials, equipment, or systems; warranty documentation; and sustainable design closeout documentation. On documents such as maintenance contracts

and bonds, include on each document furnished original (“wet”) signature of entity issuing said document. When original “wet” signatures are required, furnish such submittals in printed form and electronic form to ENGINEER, and to other entities furnish as indicated in Table 01 33 00-A.

- b. Operations and Maintenance Data: Submit in accordance with Section 01 78 23, Operation and Maintenance Data.
 - c. Record Documentation: Submit in accordance with Section 01 78 39, Project Record Documentation.
 - d. Software: Submit number of copies required in Specifications Section where the software is specified. If number of copies is not specified, provide two copies on compact disc in addition to software loaded on OWNER’s computer(s) or microprocessor(s).
4. Maintenance Material Submittals: For spare parts, extra stock materials, and tools, furnish quantity of items specified in associated Specifications Section. Furnish in accordance with Section 01 78 43, Spare Parts and Extra Materials.

F. Electronic Submittals:

- 1. Format: Electronic files shall be in “portable document format” (.PDF). Files shall be electronically searchable.
- 2. Organization and Content:
 - a. Each electronic submittal shall be one file; do not divide individual submittals into multiple files each.
 - b. When submittal is large or contains multiple parts, furnish PDF file with bookmark for each section of submittal.
 - c. Content shall be identical to printed submittal. First page of electronic submittal shall be CONTRACTOR’s letter of transmittal.
- 3. Quality and Legibility: Electronic submittal files shall be made from the original and shall be clear and legible. Do not submit scans of faxed copies. Electronic file shall be full size of original, printed documents. Properly orient all pages for reading on a computer screen.
- 4. Provide sufficient Internet service and e-mail capability for CONTRACTOR’s use in transferring electronic submittals, receiving responses to electronic submittals, and associated electronic correspondence. Check not less than once per day for distribution of electronic submittals, electronic responses of submittal, and electronic correspondence related to submittals.
- 5. Submitting Electronic Files:
 - a. Transmit electronic files in accordance with Section 01 31 26, Electronic Communication Protocols.

G. Distribution:

- 1. Distribution of ENGINEER’s Response via Electronic Files: Upon completion of ENGINEER’s review, electronic submittal response will be distributed by ENGINEER to
 - a. CONTRACTOR.
 - b. OWNER.

- c. Resident Project Representative (RPR).
- d. ENGINEER's file.

H. Resubmittals: Refer to the General Conditions for requirements regarding resubmitting required submittals.

1.5 ENGINEER'S REVIEW

- A. Timing: ENGINEER's review will conform with timing indicated in the Schedule of Submittals accepted by ENGINEER.
- B. Submittals not required by the Contract Documents will not be reviewed by ENGINEER and will not be recorded in ENGINEER's submittal log. All printed copies of such submittals will be returned to CONTRACTOR. Electronic copies of such submittals, if any, will not be retained by ENGINEER.
- C. Action Submittals, Results of ENGINEER's Review: Each submittal will be given one of the following dispositions by ENGINEER:
 - 1. Approved: Upon return of submittal marked "Approved", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents.
 - 2. Approved as Corrected: Upon return of submittal marked "Approved as Corrected", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents, and in accordance with the corrections indicated in the ENGINEER's submittal response.
 - 3. Approved as Corrected – Resubmit: Upon return of submittal marked "Approved as Corrected – Resubmit", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents, and in accordance with corrections indicated in ENGINEER's submittal response. Furnish to ENGINEER record re-submittal with all corrections made. Receipt of corrected re-submittal is required before materials or equipment covered in the submittal will be eligible for payment.
 - 4. Revise and Resubmit: Upon return of submittal marked "Revise and Resubmit", make the corrections indicated and re-submit to ENGINEER for approval.
 - 5. Not Approved: This disposition indicates material or equipment that cannot be approved. "Not Approved" disposition may also be applied to submittals that are incomplete. Upon return of submittal marked "Not Approved", repeat initial submittal procedure utilizing approvable material or equipment, with a complete submittal clearly indicating all information required.

- D. Informational Submittals, Results of ENGINEER's Review:
1. Each submittal will be given one of the following dispositions:
 - a. Accepted: Information included in submittal complies with the applicable requirements of the Contract Documents, and is acceptable. No further action by CONTRACTOR is required relative to this submittal, and the Work covered by the submittal may proceed, and materials and equipment with submittals with this disposition may be shipped or operated, as applicable.
 - b. Not Accepted: Submittal does not indicate compliance with applicable requirements of the Contract Documents and is not acceptable. Revise submittal and re-submit to indicate acceptability and compliance with the Contract Documents.
- E. Closeout Submittals, Results of ENGINEER's Review: Dispositions and meanings are the same as specified for Informational Submittals. When acceptable, Closeout Submittals will not receive a written response from ENGINEER. Disposition as "accepted" will be recorded in ENGINEER's submittal log. When Closeout Submittal is not acceptable, ENGINEER will provide written response to CONTRACTOR.
- F. Maintenance Material Submittals, Results of ENGINEER's Review: Dispositions and meanings are the same as specified for Informational Submittals. When acceptable, Maintenance Material Submittals will not receive a written response from ENGINEER. Disposition as "accepted" will be recorded in ENGINEER's submittal log. When Maintenance Material Submittal is not acceptable, ENGINEER will provide written response to CONTRACTOR, and CONTRACTOR is responsible for costs associated with transporting and handling of maintenance materials until compliance with the Contract Documents is achieved.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 42 00

REFERENCES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Section includes the following:
 - a. Definitions and terminology in general use in the Contract Documents.
 - b. Applicable codes.
 - c. Owner's referenced specifications, where applicable.
 - d. Abbreviations in general use throughout the Contract Documents.
 - e. General requirements regarding reference standards, including a listing of standard-issuing organizations (and their acronyms) used in the Contract Documents.

1.2 DEFINITIONS AND TERMINOLOGY

- A. Definitions and terminology applicable to all the Contract Documents are included in the General Conditions, as may be modified by the Supplementary Conditions.
- B. Additional terminology used in the Contract Documents includes the following:
 - 1. "Indicated" refers to graphic representations, notes, or schedules on the Drawings, or to other paragraphs, provisions, tables, or schedules in the Specifications and similar locations in the other Contract Documents. Terminology such as "shown", "noted", "scheduled", and "specified" are used to help the user locate the reference without limitation on the location.
 - 2. "Installer", "applicator", or "erector" is CONTRACTOR or another person or entity engaged by CONTRACTOR, either as an employee or Subcontractor, to perform a particular construction activity, including installation, erection, application, or similar Work. Installers shall be experienced in the Work that installer is engaged to perform.
 - a. The term "experienced", when used in conjunction with the term "installer", means having successfully completed not less than five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated and required; being familiar with Laws and Regulations; and having complied with requirements of authorities having jurisdiction, and complying with requirements of the Supplier of the material or equipment being installed, unless other experience requirements specific to that element of the Work are indicated elsewhere in the Contract Documents.
 - 3. Trades: Use of terms such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter", unless

otherwise indicated in the Contract Documents or required by Laws or Regulations. Such terminology also does not imply that specified requirements apply exclusively to trade personnel of the corresponding generic name.

1.3 APPLICABLE CODES

- A. References in the Contract Documents to local code(s) shall mean the following:
1. International Existing Building Code, as adopted by the Town of Trumbull.
 2. International Electric Codes, as adopted by the Town of Trumbull.
 3. International Plumbing Code, as adopted by the Town of Trumbull.
 4. International Fire Code, as adopted by the Town of Trumbull.
 5. International Energy Conservation Codes, as adopted by the Town of Trumbull.
 6. National Electric Code in effect at the location of the Project.
 7. NFPA 101, Life Safety Code.

1.4 ABBREVIATIONS

- A. Common abbreviations that may be found in the Contract Documents are indicated below, alphabetically by their written-out meaning:

alternating current	a-c
ampere	A
antemeridian	a.m.
Architectural Barriers Act	ABA
Americans with Disabilities Act	ADA
Americans with Disabilities Act Accessibility Guidelines	ADAAG
ante meridian	a.m.
average	avg
biochemical oxygen demand	BOD
five-day biochemical oxygen demand	BOD ₅
brake horsepower	bhp
British thermal unit	Btu
building information model	BIM
carbonaceous biochemical oxygen demand	CBOD
five-day carbonaceous biochemical oxygen demand	CBOD ₅
chemical oxygen demand	COD
Centigrade (or Celsius)	C
chlorinated polyvinyl chloride	CPVC
chlorofluorocarbons	CFC
Code of Federal Regulations	CFR

computer-aided drafting and design		CADD, or CAD
cubic inch		cu in
cubic foot		cu ft
cubic yard		cu yd, or CY
cubic feet per minute		cfm
cubic feet per second		cfs
decibel		db
degree Centigrade (or Celsius)	(Write)	degrees C, °C, or deg C
degrees Fahrenheit		degrees F, °F, or deg F
diameter		dia
direct current		d-c
dollars		\$
each		ea
efficiency		eff
Fahrenheit		F
feet		ft
feet per hour		fph, or ft/hr
feet per minute		fpm
feet per second		fps, or ft/min
figure		fig
flange		flg
foot-pound		ft-lb
gallon		gal
gallons per hour		gph, or gal/hr
gallons per minute		gpm
gallons per second		gps
gram		g
grams per liter		g/L
Hertz		Hz
horsepower		hp or HP
hour		hr
human-machine interface		HMI
inch		in.
inches of mercury		in. Hg
inches water gage		in. w.g.
inch-pound		in.-lb

inside diameter	ID
iron pipe size	IPS
thousand pounds	kips
thousand pounds per square inch	ksi
kilovolt-ampere	kva
kilowatt	kw
kilowatt-hour	kwhr or kwh
linear foot	lin ft or LF
liter	L
Leadership in Energy and Environmental Design (USGBC)	LEED
maximum	max
mercury	Hg
milligram	mg
milligrams per liter	mg/l or mg/L
milliliter	ml
millimeter	mm
million gallons per day	mgd or MGD
million gallon	MG
minimum	min
national pipe threads	NPT
net positive suction head	NPSH
net positive suction head available	NPSHA
net positive suction head required	NPSHR
nitrogen oxide (total concentration of mono-nitrogen oxides such as nitric oxide (NO) and nitrogen dioxide (NO ₂))	NO _x
nominal pipe size	NPS
number	no.
operator interface terminal	OIT
ounce	oz
ounce-force	ozf
outside diameter	OD
parts per hundred	pph
parts per million	ppm
parts per billion	ppb
polyvinyl chloride	PVC
post meridian	p.m.

pound	lb
pounds per square inch	psi
pounds per square inch absolute	psia
pounds per square inch gauge	psig
pounds per square foot	psf
process control system	PCS
programmable logic controller	PLC
revolutions per minute	rpm
second	sec
specific gravity	sp gr, or SG
square	sq
square foot	sq ft, sf, or ft ²
square inch	sq in., or in ²
square yard	sq yd, or SY
standard	std
standard cubic feet per minute	scfm
total dynamic head	TDH
totally-enclosed fan-cooled	TEFC
volt	V
volts alternating current	vac
volts direct current	vdc
volatile organic compounds	VOC

1.5 REFERENCE STANDARDS

- A. Refer to Article 3 of the General Conditions, as may be modified by the Supplementary Conditions, relative to reference standards and resolving discrepancies between reference standards and the Contract Documents. Provisions of reference standards are in effect in accordance with the Specifications.
- B. Copies of Standards: Each entity engaged in the Work shall be familiar with reference standards applicable to its construction activity. Copies of applicable reference standards are not bound with the Contract Documents. Where reference standards are needed for a construction activity, obtain copies of standards from the publication source.
- C. Abbreviations and Names: Where reference standards, specifications, codes, manuals, Laws or Regulations, or other published data of international, national, regional or local organizations are referred to in the Contract Documents, the organization issuing the standard may be referred to by their acronym or abbreviation

only. The following acronyms or abbreviations that may appear in the Contract Documents shall have the meanings indicated below. Listing is alphabetical by acronym.

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACS	American Chemical Society
ADSC- IAFD	International Association of Foundation Drilling.
AEIC	Association of Edison Illuminating Companies
AF&PA	American Forest and Paper Association
ABMA	American Bearing Manufacturers Association (formerly Anti-Friction Bearing Manufacturers Association (AFBMA))
AGMA	American Gear Manufacturers Association
AI	Asphalt Institute
AIA	American Institute of Architects
AIChE	American Institute of Chemical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALSC	American Lumber Standards Committee
AMA	Acoustical Materials Association
AMCA	Air Movement and Control Association
AMP	National Association of Architectural Metal Manufacturers, Architectural Metal Products Division
ANSI	American National Standards Institute
APA	The Engineered Wood Association
APHA	American Public Health Association
API	American Petroleum Institute
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers

ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASQ	American Society for Quality
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
AWCI	Association of the Wall and Ceiling Industry
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BAAQM D	Bay Area Air Quality Management District
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association
CBMA	Certified Ballast Manufacturers Association
CDA	Copper Development Association
CEMA	Conveyor Equipment Manufacturers Association
CGA	Compressed Gas Association
CISCA	Ceilings and Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CMAA	Crane Manufacturers Association of America
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DIN	Deutsches Institut für Normung eV (German Institute for Standardization)
DIPRA	Ductile Iron Pipe Research Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ETL	Intertek Testing Services, Inc. (formerly ETL Testing Laboratories, Inc.)
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FM	Factory Mutual (FM Global)
FRPI	Fiberglass Reinforced Plastics Institute
FS	Federal Specification
GA	Gypsum Association

GANA	Glass Association of North America
HEW	United States Department of Health, Education and Welfare
HI	Hydraulic Institute
HMI	Hoist Manufacturers Institute
HUD	United States Department of Housing and Urban Development
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFI	Industrial Fasteners Institute
IRI	Industrial Risk Insurers
ISA	Instrumentation, Systems, and Automation Society (formerly Instrument Society of America)
ISO	Insurance Services Office
ISO	International Organization for Standardization
LPI	Lightning Protection Institute
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MS	Military Specifications
MSS	Manufacturers' Standardization Society
MMA	Monorail Manufacturers Association
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators, Inc.
NARUC	National Association of Regulatory Utilities Commissioners
NBHA	National Builders Hardware Association
NBS	United States Department of Commerce, National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electric Code
NELMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association

NHPMA	Northern Hardwood and Pine Manufacturers Association
NIST	United States Department of Commerce, National Institute of Standards and Technology
NLGA	National Lumber Grades Authority
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	National Sanitation Foundation
NSSGA	National Stone, Sand, and Gravel Association
NTMA	National Terrazzo and Mosaic Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PEI	Porcelain Enamel Institute
PFI	Pipe Fabrication Institute
PPI	Plastics Pipe Institute
PGMC	Primary Glass Manufacturers Council
PS	Product Standards Section, United States Department of Commerce
RCSC	Research Council on Structural Connections (part of AISC)
RMA	Rubber Manufacturers Association
SAE	Society of Automotive Engineers
SCAQMD	Southern California Air Quality Management District
SCPRF	Structural Clay Products Research Foundation
SCTE	Society of Cable Telecommunications Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturing Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SPI	Society of the Plastics Industry
SPIB	Southern Pine Inspection Bureau
SSPC	Society for Protective Coatings
SWI	Steel Window Institute
TCNA	Tile Council of North America
TEMA	Tubular Exchanger Manufacturers Association
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
UL	Underwriters Laboratories, Inc.

USAB	United States Access Board
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USGBC	United States Green Building Council
USGS	United States Geological Survey
USPHS	United States Public Health Service
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association
WCMA	Wood Component Manufacturers Association
WDMA	Window and Door Manufacturers Association
WEF	Water Environment Federation
WWEMA	Water and Wastewater Equipment Manufacturers Association
WWPA	Western Wood Products Association

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 45 29

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
1. CONTRACTOR shall employ and pay for services of independent testing laboratory to perform specified services.
 2. Inspection, sampling, and testing shall be as specified in the Specifications including but not limited to:
 - a. Section 01 45 33, Code-Required Special Inspections and Procedures.
 - b. Section 03 00 05, Concrete.
 - c. Section 04 00 05, Masonry.
 - d. Section 05 05 33, Anchor Systems.
 - e. Section 09 91 00, Painting.
 - f. Section 31 20 00, Earth Moving .
 - g. Section 33 05 05, Buried Piping Installation.
 - h. Section 40 05 05, Exposed Piping Installation.
 - i. Other tests indicated in the Contract Documents that are not specifically assigned to others.
 3. CONTRACTOR shall pay for:
 - a. Tests not specifically indicated in the Contract Documents as being OWNER's responsibility.
 - b. Tests made for CONTRACTOR's convenience.
 - c. Repeat tests required because of CONTRACTOR's negligence or defective Work, and retesting after failure of test for the same item to comply with the Contract Documents.
 4. Testing laboratory is not authorized to approve or accept any portion of the Work or defective Work; rescind, alter, or augment requirements of Contract Documents; and perform duties of CONTRACTOR.

1.2 REFERENCES

- A. Standards referenced in this Section are:
1. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
 2. ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories.
 3. NIST SRM, Standard Reference Materials.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Testing Laboratory:
 - a. Comply with applicable requirements of ASTM E329.
 - b. Testing laboratory shall be licensed to operate in the same jurisdiction as the Site. Where applicable, laboratory shall be certified by the authority having jurisdiction for the types of testing required.
 - c. Testing equipment used by laboratory shall be calibrated at intervals of not more than twelve months by devices of accuracy traceable to one of the following: NIST SRM, ISO/IEC 17025, certified by state or local bureau of weights and measures, or values of natural physical constants generally accepted in the engineering and scientific community.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Quality Control Submittals and Test Reports: Testing laboratory shall promptly submit to CONTRACTOR results of testing and inspections, including:
 - a. Date issued.
 - b. Project title, number, and name of the Site.
 - c. Testing laboratory name and address.
 - d. Name and signature of inspector or person obtaining samples.
 - e. Date of inspection or sampling.
 - f. Record of temperature and weather conditions.
 - g. Date of test.
 - h. Identification of material or item tested, and associated Specifications Section.
 - i. Location in the Project.
 - j. Type of inspection or test.
 - k. Results of tests and observations regarding compliance with the Contract Documents.
2. Qualifications Statements:
 - a. Testing Laboratory:
 - 1) Qualifications statement indicating experience and facilities for tests required under the Contract Documents.
 - 2) Copy of report of inspection of facilities during most recent NIST inspection tour. Include memorandum of remedies of deficiencies reported during inspection.
 - 3) Copy of certificate of calibration for each instrument or measuring device proposed for use, by accredited calibration agency.

1.5 TESTING LABORATORY DUTIES

A. Testing laboratory shall:

1. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
2. Perform required inspections, sampling, and testing of materials and methods of construction; comply with applicable reference standards and the Contract Documents; and ascertain compliance with requirements of the Contract Documents.
3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies in the Work that are observed during performance of services.
4. Promptly submit to CONTRACTOR reports of inspections and tests.
5. Perform additional tests and services, as required by CONTRACTOR.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. CONTRACTOR shall:

1. Cooperate with testing laboratory personnel.
2. Provide to testing laboratory preliminary representative samples of materials and items to be tested, in required quantities.
3. Promptly submit to ENGINEER results of tests and inspections received from testing laboratory.
4. Furnish to laboratory the preliminary design mix proposed for concrete and other material mixes to be tested by testing laboratory.
5. Provide labor and facilities:
 - a. For access to the Work to be tested, and where required, to Suppliers' operations.
 - b. For obtaining and handling samples at the Site.
 - c. For facilitating inspections and tests.
 - d. For testing laboratory's exclusive use for storing and curing of test samples.
 - e. Forms for preparing concrete test beams and cylinders.
6. Notify laboratory and ENGINEER sufficiently in advance of operations to allow assignment of personnel and scheduling of tests.
7. Arrange with laboratory and pay for additional services, sampling, and testing required for CONTRACTOR's convenience.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 45 33.00

CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope
 - 1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to cooperate with the Coordinating Special Inspector and individual special inspectors employed by OWNER, and to perform required testing and inspections. CONTRACTOR shall engage the services of testing agencies as needed to facilitate Special Inspections.
 - 2. Supplement A, Statement of Special Inspections, included with this Section, lists testing and inspections required.

1.2 DEFINITIONS

- A. Coordinating Special Inspector: Professional engineer or architect, hired by OWNER, registered in the same state as the Site, responsible for coordinating and verifying the inspection and testing required by the Statement of Special Inspections included in this Section and reporting to the Building Official.
- B. Building Official: Officer or other designated authority having jurisdiction charged with the administration and enforcement of the governing building code, or a duly authorized representative.
- C. Special Inspections: Testing and inspection required in Supplement A, Statement of Special Inspections, of this Section.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. OWNER will employ and pay for services of the Coordinating Special Inspector, who will have not less than five years of experience in managing, monitoring, and inspecting building construction.
 - 2. Special Inspections shall be in accordance with applicable building code Laws and Regulations, and the Statement of Special Inspections, prepared by the SER.
 - 3. Inspectors will be qualified in the responsibilities of the Special Inspection for which each is responsible.

- B. Regulatory Requirements:
 - 1. Special Inspections shall be in accordance with applicable building code and other Laws and Regulations, and Supplement A, Statement of Special Inspections, of this Section.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Samples: Representative Samples of materials when required by ENGINEER.
- B. Informational Submittals: Submit the following:
 - 1. Completed Supplement C, Contractor's Statement of Responsibility, as attached to this Section, addressing each system and component listed in the Quality Assurance Plan portion of Supplement A, Statement of Special Inspections, of this Section.
 - 2. Completed Supplement D, Fabricator's Certificate of Compliance, as attached to this Section, for fabrication of structural steel.
 - 3. Site Quality Control Submittals: Material test reports.
 - 4. Procedure Submittals: List of control procedures within CONTRACTOR's organization for testing, including methods, frequency of reporting, and distribution of testing reports.
 - 5. Qualifications Statements:
 - a. Names and qualifications of each testing agency to be employed, and qualifications of testing agency's personnel that will perform testing as required in Supplement A, Statement of Special Inspections, of this Section.

1.5 CONTRACTOR'S RESPONSIBILITIES

- A. Prepare Supplement C, Contractor's Statement of Responsibility, of this Section which shall include:
 - 1. Acknowledgment of the requirements of the Quality Assurance Plan portion of Supplement A, Statement of Special Inspections, of this Section.
 - 2. Acknowledgment that necessary quality control shall be exercised in fabricating, handling, and installing to conform to the Contract Documents.
 - 3. List CONTRACTOR's procedures for ensuring the quality of the Work required for compliance with the Contract Documents relative to each system or component listed in the Quality Assurance Plan portion of Supplement A of this Section.
 - 4. List personnel who control the quality of the Work relative to the Contract Documents and indicate their position in CONTRACTOR's organization.
- B. Employ testing agencies with personnel that comply with qualifications requirements in Supplement A, Statement of Special Inspections, of this Section.
- C. Provide safe access to the Work to be tested and inspected.

- D. Obtain and handle test samples at the Site.
- E. Facilitate inspections and tests.
- F. Provide access to Suppliers' and Subcontractors' operations as required.
- G. Notify testing agencies, Coordinating Special Inspector, and ENGINEER sufficiently in advance of the Work for the testing agencies, Coordinating Special Inspector, and ENGINEER to coordinate their personnel at the Site. Do not cover the Work to be inspected until Special Inspections have been completed and the results thereof are acceptable.
- H. Special Inspections required in this Section do not supersede or make unnecessary inspections and tests required under other Specification Sections or standard inspections required by Laws and Regulations.

1.6 COORDINATING SPECIAL INSPECTOR'S RESPONSIBILITIES

- A. Coordinating Special Inspector will:
 - 1. Hire special inspectors to provide inspections listed Supplement A, Statement of Special Inspections, of this Section and as required by Laws and Regulations, and laws.
 - 2. Review testing agencies and testing personnel submitted by CONTRACTOR, relative to compliance with Supplement A, Statement of Special Inspections, of this Section, and in accordance with Laws and Regulations.
 - 3. Complete Supplement A, Statement of Special Inspections, of this Section to provide names of each inspector and testing agency for each Special Inspection required. Provide Supplement A, Statement of Special Inspections, of this Section to the Building Official, OWNER, ENGINEER, and CONTRACTOR.
 - 4. Coordinate activities of individual inspectors and testing agencies with CONTRACTOR.
 - 5. Provide interim reports of inspections and material testing to Building Official, OWNER, ENGINEER, and ENGINEER's consultants, including structural engineer and architect.
 - 6. To obtain certificate of use and occupancy from the Building Official, complete and provide to the Building Official, OWNER, and ENGINEER Supplement B, Final Report of Special Inspections, of this Section, documenting completion of Special Inspections and correction of discrepancies noted in the Special Inspections.

1.7 INSPECTOR RESPONSIBILITIES

- A. Perform specified inspections, sampling, and testing of materials and methods of construction; review and ascertain compliance with Laws and Regulations.
- B. Promptly notify Coordinating Special Inspector, OWNER, ENGINEER and CONTRACTOR of irregularities or deficiencies in the Work observed during

Special Inspections. Corrective action, if required, will be determined by ENGINEER.

- C. Promptly submit two copies of each report of inspections and tests to Coordinating Special Inspector, ENGINEER, and CONTRACTOR including:
1. Date issued.
 2. Project title and number.
 3. Name and signature of inspector.
 4. Date of inspection or sampling and test.
 5. Record of temperature and weather.
 6. Identification of product and Specification Section.
 7. Location in Project.
 8. Type of inspection or test.
 9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SUPPLEMENTS

- A. The supplements listed below, following the “End of Section” designation, are part of this Section:
1. Supplement A – Statement of Special Inspections
 2. Supplement B – Final Report of Special Inspections
 3. Supplement C – Contractor’s Statement of Responsibility
 4. Supplement D – Fabricator’s Certificate of Compliance

+ + END OF SECTION + +

Supplement A - Statement of Special Inspections

Project: Beardsley Pump Station Comprehensive Upgrade

Location: Trumbull, CT

Owner: Town of Trumbull

Design Professional in Responsible Charge:

This *Statement of Special Inspections* is submitted as a condition for permit issuance in accordance with the Special Inspection and Structural Testing requirements of the Building Code. It includes a schedule of Special Inspection services applicable to the Project as well as the name of the Coordinating Special Inspector and the identity of other approved agencies to be retained for conducting these inspections and tests. This *Statement of Special Inspections* encompass the following disciplines:

☒ Structural
 ☐ Mechanical/Electrical
☐ Architectural
 ☐ Other: _____

The Coordinating Special Inspector shall keep records of all inspections and shall furnish inspection reports to the Building Official and the Registered Design Professional in Responsible Charge. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Registered Design Professional in Responsible Charge. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Inspections listed are periodic unless indicated to be continuous or required by code to be continuous.

Interim reports shall be submitted to the Building Official and the Registered Design Professional in Responsible Charge.

A *Final Report of Special Inspections* documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Interim Report Frequency: Weekly or ☐ per attached schedule.

Prepared by:

(type or print name)

Signature

Date

Owner's Authorization:

Building Official's Acceptance:

Signature

Date

Signature

Date

06532002.0000

01 45 33-5

Schedule of Inspection and Testing Agencies

This Statement of Special Inspections / Quality Assurance Plan includes the following building systems:

☐ Soils and Foundations	☐ Spray Fire Resistant Material
☒ Cast-in-Place Concrete	☐ Wood Construction
☐ Precast Concrete	☐ Exterior Insulation and Finish System
☒ Masonry	☐ Mechanical & Electrical Systems
☒ Structural Steel	☐ Architectural Systems
☐ Anchor Systems	☐ Special Cases

Special Inspection Agencies	Firm	Address, Telephone, e-mail
1. Coordinating Special Inspector		
2. Inspector		
3. Inspector		
4. Testing Agency		
5. Testing Agency		
6. Other		

Note: The inspectors will be engaged by Owner or Owner's Agent, and not by Contractor or Subcontractor whose Work is to be inspected or tested. Testing agencies shall be engaged and paid for by Contractor. Conflicts of interest must be disclosed to the Building Official prior to commencing the Work.

Statement of Responsibility

Each contractor responsible for the construction or fabrication of a system or component designated above must submit a Statement of Responsibility.

Qualifications of Inspectors and Testing Technicians

The qualifications of all personnel performing Special Inspections are subject to the approval of the Building Official. The credentials of all inspectors and testing technicians shall be provided if requested.

Key for Minimum Qualifications of Inspection Agents:

When Engineer deems it appropriate that the individual performing a stipulated test or inspection have a specific certification or license as indicated below, such designation shall appear below the *Agency Number* on the Schedule.

PE/SE	Structural Engineer – a licensed SE or PE specializing in the design of building structures
PE/GE	Geotechnical Engineer – a licensed PE specializing in soil mechanics and foundations
EIT	Engineer-In-Training – a graduate engineer who has passed the Fundamentals of Engineering examination

American Concrete Institute (ACI) Certification

ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1&2
ACI-STT	Strength Testing Technician

American Welding Society (AWS) Certification

AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector

American Society of Non-Destructive Testing (ASNT) Certification

ASNT	Non-Destructive Testing Technician – Level II or III.

International Code Council (ICC) Certification

ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fireproofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector

National Institute for Certification in Engineering Technologies (NICET)

NICET-CT	Concrete Technician – Levels I, II, III & IV
NICET-ST	Soils Technician - Levels I, II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels I, II, III & IV

Exterior Design Institute (EDI) Certification

EDI-EIFS	EIFS Third Party Inspector

Other

Cast-in-Place Concrete

Item	Agency # (Qualif.)	Scope
1. Mix Design	ACI-CCI ICC-RCSI	Review concrete batch tickets and verify compliance with approved mix design. Verify that water added at the site does not exceed that allowed by the mix design.
2. Material Certification	PE/SE	Review trial batch or supporting test data to verify mix meets specified requirements. Confirm materials meet specified requirements.
3. Reinforcement Installation	ACI-CCI ICC-RCSI	Inspect size, spacing, cover, positioning and grade of reinforcing steel. Verify that reinforcing bars are free of form oil or other deleterious materials. Inspect bar laps and mechanical splices. Verify that bars are adequately tied and supported on chairs or bolsters
4. Formwork Geometry		Inspect formwork for proper materials, dimensions and alignment.
5. Welding of Reinforcing	AWS-CWI	Visually inspect all reinforcing steel welds. Verify weldability of reinforcing steel. Inspect preheating of steel when required.
6. Anchor Rods	ACI-CCI ICC-RCSI	Inspect size, positioning and embedment of anchor rods. Inspect concrete placement and consolidation around anchors. (continuous)
7. Concrete Placement	ACI-CCI ICC-RCSI	Inspect placement of concrete. Verify that concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated. (continuous)
8. Sampling and Testing of Concrete	ACI-CFTT ACI-STT	Test concrete compressive strength (ASTM C31 & C39), slump (ASTM C143), air-content (ASTM C231) and temperature (ASTM C1064).
9. Curing and Protection	ACI-CCI ICC-RCSI	Inspect curing, cold weather protection and hot weather protection procedures.
10. Other:		

Masonry

Required Inspection Level: ☐ 1 ☒ 2

Page 7 of 13

Item	Agency # (Qualif.)	Scope
1. Material Certification	PE/SE	- Confirm size and strength of masonry units. - Confirm grout mix design and materials. - Confirm mortar mix design and materials
2. Mixing of Mortar and Grout	ICC-SMSI	Inspect proportioning, mixing and retempering of mortar and grout. (continuous)
3. Installation of Masonry	ICC-SMSI	Inspect size, layout, bonding and placement of masonry units.
4. Mortar Joints	ICC-SMSI	Inspect construction of mortar joints including tooling and filling of head joints.
5. Reinforcement Installation	ICC-SMSI AWS-CWI	- Inspect placement, positioning and lapping of reinforcing steel. - Inspect welding of reinforcing steel. (continuous)
6. Grouting Operations	ICC-SMSI	- Inspect that masonry cells are clear of debris prior to grouting. - Inspect placement and consolidation of grout. (continuous)
7. Weather Protection	ICC-SMSI	Inspect cold weather protection and hot weather protection procedures. Verify that wall cavities are protected against precipitation.
8. Evaluation of Masonry Strength	ICC-SMSI	Test compressive strength of mortar and grout cube samples (ASTM C780).
9. Anchors and Ties	ICC-SMSI	Inspect size, location, spacing and embedment of dowels, anchors and ties.
10. Other:		

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures ☐ Fabricator Exempt	PE/SE AWS/AIS C-SSI ICC-SWSI	- Verify fabricator has certification from AISC for conventional buildings of the AISC Quality Certification Program and has approval by the Building Official. - Review fabricator's certificate of compliance.
2. Material Certification	AWS/AIS C-SSI ICC-SWSI	Review certified mill test reports and identification markings on wide-flange shapes, high-strength bolts, nuts and welding electrodes
3. Bolting	AWS/AIS C-SSI ICC-SWSI	Inspect installation and tightening of high-strength bolts. Verify that splines have separated from tension control bolts. Verify proper tightening sequence. Continuous inspection of bolts in slip-critical connections.
4. Welding	AWS-CWI ASNT	- Visually inspect all welds. Inspect pre-heat, post-heat and surface preparation between passes. Verify size and length of fillet welds. (continuous for all field welds) - Ultrasonic testing of all partial and full-penetration welds.
5. Shear Connectors	AWS/AIS C-SSI ICC-SWSI	Inspect size, number, positioning and welding of shear connectors. Inspect studs for full 360 degree flash. Ring test all shear connectors with a 3 lb hammer. Bend test all questionable studs to 15 degrees.
6. Structural Details	PE/SE	Inspect steel frame for compliance with structural drawings, including bracing, member configuration and connection details.
7. Metal Deck	PE/SE AWS-CWI	- Review manufacturer's certificate of compliance with ASTM standards specified. Verify decking section profile, gage, and properties conform to contract documents. - Inspect welding and side-lap fastening of metal roof and floor deck.
8. Other:		

Anchor Systems

Item	Agency # (Qualif.)	Scope
1. Material Certification	PE/SE	- Confirm anchor type (including product name), anchor dimensions, and anchor material grade for each anchor application. - Confirm post-installed anchor compliance with specified requirements and suitability for each application type by review of the anchor system ICC-ES Evaluation Service Report. - For adhesive anchors, confirm adhesive type
2. Installation of Adhesive Anchors for Concrete, Grout-filled Masonry, and Hollow Concrete Masonry	ICC-RCSI ICC-SMSI	- Review compliance with the installation requirements of the anchor system ICC Evaluation Service Report. - Verify and record anchor type (including product name), anchor dimensions, anchor material grade, adhesive type, adhesive expiration date, concrete or masonry type, base material compressive strength, drill bit type, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, anchor embedment, curing period prior to tightening, and tightening torque. - Inspect installation of each type and size of adhesive anchor by construction personnel on the site. (continuous)
3. Installation of Concrete and Grout-filled Masonry Wedge Expansion Anchors	ICC-RCSI ICC-SMSI	- Review compliance with the installation requirements of the anchor system ICC Evaluation Service Report. - Verify and record anchor type (including product name), anchor dimensions, anchor material grade, concrete or masonry type, base material compressive strength, drill bit type, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, anchor embedment and tightening torque. - Inspect installation of each type and size of wedge anchor by construction personnel on the site. (continuous)
4. Anchor Testing	ASNT	Perform tension pullout test on 10 percent of each post-installed anchor type and size.

Supplement B - Final Report of Special Inspections

Project: Beardsley Pump Station Comprehensive Upgrade

Location: Trumbull, CT

Owner: Town of Trumbull

Owner's Address: 5866 Main Street, Trumbull CT

Architect of Record:

Structural Engineer of Record:

To the best of my information, knowledge and belief, the Special Inspections required for this project, and itemized in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,
Special Inspector

(Type or print name)

Signature

Date

Licensed Professional Seal

Agent's Final Report

Project: Beardsley Pump Station Comprehensive Upgrade

Agent:

Special Inspector:

To the best of my information, knowledge and belief, the Special Inspections or testing required for this project, and designated for this Agent in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,
Agent of the Special Inspector

(Type or print name)

Signature

Date

*Licensed Professional Seal or
Certification*

Supplement C - Contractor's Statement of Responsibility

Each contractor responsible for the construction or fabrication of a system or component designated in the Quality Assurance Plan of Supplement A shall submit a Contractor's Statement of Responsibility.

Project: Beardsley Pump Station Comprehensive Upgrade

Contractor's Name:

Address:

License No.:

Description of designated building systems and components included in the Contractor's Statement of Responsibility:

Contractor's Acknowledgment of Special Requirements

I hereby acknowledge that I have received, read, and understand the Project's seismic requirements, Quality Assurance Plan in Supplement A, and Special Inspection program.

I hereby acknowledge that control will be exercised to obtain conformance with the Contract Documents approved by the Building Official having jurisdiction.

Signature

Date

Contractor's Provisions for Quality Control

Procedures for exercising control within the Contractor's organization, the method and frequency of reporting and the distribution of reports are attached to this Statement.

Identification and qualifications of the person(s) exercising such control and their position(s) in the organization are attached to this Statement.

Supplement D - Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section 1704.2 of the International Building Code must submit a *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project: Beardsley Pump Station Comprehensive Upgrade

Fabricator's Name:

Address:

Certification or Approval Agency:

Certification Number:

Date of Last Audit or Approval:

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with the Contract Documents.

Signature

Date

Title

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

++ NO TEXT ON THIS PAGE ++

SECTION 01 51 05

TEMPORARY UTILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all temporary utilities and temporary facilities required for the Project, including the following:
 - a. Electricity.
 - b. Lighting.
 - c. Telephone and communications.
 - d. Heating, cooling, ventilating, and temporary enclosures.
 - e. Water.
 - f. Sanitary facilities.
 - g. First-aid facilities.
 - h. Fire protection.
2. Make all arrangements with utility owners for temporary utilities and with others as appropriate for temporary facilities. Obtain required permits and approvals for temporary utilities and temporary facilities.
3. Pay all service costs for utilities and facilities indicated in this Section as CONTRACTOR's responsibility, including cost of electricity, water, fuel, and other utility services and temporary facilities required for the Work.
4. Continuously maintain adequate temporary utilities and temporary facilities for all purposes for the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities and temporary facilities through Substantial Completion and removal of temporary field offices and sheds unless otherwise approved in writing by ENGINEER.
5. Should OWNER occupy part of the Work prior to Substantial Completion of the entire Work, cost of utilities consumed via temporary utilities serving the portion occupied by OWNER will be shared proportionately by OWNER and CONTRACTOR as mutually agreed to by the parties.
6. Maintain, including cleaning, temporary utilities and temporary facilities, and continuously provide consumables as required.
7. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and the needs of the Project.
8. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.

1.2 REQUIREMENTS FOR TEMPORARY UTILITIES AND TEMPORARY FACILITIES

A. Electrical:

1. Provide temporary electrical service required for the Work, including continuous power for temporary field offices and sheds. Provide temporary outlets with circuit breaker protection and ground fault protection.
- B. Lighting.
1. Provide lighting at the Site of not less than five foot-candles for open areas and not less than ten foot-candles for stairs and shops. Provide not less than one, 300-watt lamp every 15 feet in indoor work areas. Provide night security lighting of not less than five foot-candles within 50 feet of all parts of the Site during hours of darkness, controlled by photocell.
 2. Do not work in areas with insufficient lighting. Where lighting is insufficient for the work activities to be performed, provide additional temporary lighting.
 3. Provide temporary lighting sufficient for observation of the Work by ENGINEER and inspection by CONTRACTOR and authorities having jurisdiction. Where required by ENGINEER, provide additional temporary lighting.
 4. Provide temporary lighting for ENGINEER's field office in accordance with Section 01 52 11, Engineer's Field Office.
- C. Telephone and Communications.
1. Provide temporary telephone and communications required for CONTRACTOR's operations at the Site and for summoning emergency medical assistance.
- D. Heating, Ventilating, and Enclosures.
1. Provide sufficient temporary heating, cooling, ventilating, and enclosures to ensure safe working conditions and prevent damage to existing facilities and the Work.
 2. Except where otherwise specified, temporary heating shall maintain temperature of the space served between 50 degrees F and maximum design temperature of building or facility and its contents.
 3. Maintain temperature of areas occupied by OWNER's personnel or electronic equipment, including offices, lunch rooms, locker rooms, toilet rooms, and rooms containing computers, microprocessors, and control equipment, between 65 degrees F and 80 degrees F with relative humidity less than 75 percent.
 4. Required temperature range for storage areas and certain elements of the Work, including preparation of materials and surfaces, installation or application, and curing as applicable, shall be in accordance with the Contract Documents for the associated Work and the Supplier's recommended temperature range for storage, application, or installation, as appropriate.
 5. Provide temporary ventilation sufficient to prevent accumulation in construction areas and areas occupied by OWNER of hazardous and nuisance levels or concentrations of dust and particulates, mist, fumes or vapors, odors, and gases, associated with construction.
 6. Provide temporary enclosures and partitions required to maintain required temperature and humidity.

- E. Water:
 - 1. General:
 - a. Provide temporary water facilities including piping, valves, meters if not provided by owner of existing waterline, backflow preventers, pressure regulators, and other appurtenances. Provide freeze-protection as required.
 - b. Continuously maintain adequate water flow and pressure for all purposes during the Project, until removal of temporary water systems.
 - 2. Water for Construction Purposes:
 - a. Provide water for Site maintenance and cleaning and, water necessary for construction activities, and water for disinfecting and testing of systems.
 - b. CONTRACTOR may use existing hose bibbs for short-term wash-downs and intermittent use of water for work areas in the existing building. Obtain consent of ENGINEER and OWNER if connections to existing hose bibbs and similar existing connections will be used for more than one day at a time.
 - 3. Water for Human Consumption and Sanitation:
 - a. Provide potable water in accordance with Laws and Regulations for consumption by personnel at the Site, for field offices, and for sanitary facilities.
 - b. When necessary, provide bottled, potable water for use and consumption by personnel at the Site, including CONTRACTOR, ENGINEER, and visitors to the Site.
- F. Sanitary Facilities.
 - 1. Provide suitably-enclosed chemical or self-contained toilets for CONTRACTOR's employees, Subcontractors, Suppliers, ENGINEER, and visitors to the Site. Location of temporary toilets shall be acceptable to OWNER and ENGINEER.
 - 2. Refer to Paragraph 1.2.E of this Section for requirements for water intended for human consumption during construction.
 - 3. Provide suitable temporary washing facilities for employees and visitors.
- G. First-aid Facilities.
 - 1. Provide temporary first-aid stations at or immediately adjacent to the Site's work areas, and inside CONTRACTOR's temporary field office. Locations of first-aid stations shall be determined by CONTRACTOR's safety representative. Replenish supplies in first-aid stations as items are used, prior to expiration of items, and as necessary.
 - 2. Provide list of emergency telephone numbers at each hardwired telephone at the Site.
- H. Fire Protection.
 - 1. Provide temporary fire protection, including portable fire extinguishers rated not less than 2A or 5B in accordance with NFPA 10, Portable Fire Extinguish-

ers, for each temporary building and for every 3,000 square feet of floor area under construction.

2. Provide Class A (ordinary combustibles), Class B (combustible liquids and gases), and Class C (electrical equipment) fire extinguishers as necessary.
3. Comply with NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.

1.3 USE OF OWNER'S SYSTEM

- A. Existing Utility Systems: Do not use systems in existing buildings or structures for temporary utilities without OWNER's written permission and mutually acceptable basis agreed upon by the parties for proportionate sharing of costs between OWNER and CONTRACTOR.
- B. Use of Permanent Utility Systems Provided Under the Project:
 1. Permanent electrical, lighting, water, heating, ventilating, and fire protection systems and first-aid facilities may be used to provide temporary utilities and temporary facilities if the following are met:
 - a. Obtain OWNER's written permission to use permanent systems.
 - b. Permanent systems to be used for temporary utilities or temporary facilities shall be substantial complete, including complete functionality of all controls.
 - c. CONTRACTOR shall pay all costs while using permanent system, including operation, maintenance, replacement of consumables, and provide replacement parts.
 2. Do not use the following permanent facilities:
 - a. Telephone and communication facilities.
 - b. Sanitary facilities.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for temporary utilities and temporary facilities may be new or used, but shall be adequate for purposes intended and shall not create unsafe conditions, and shall comply with Laws and Regulations.
- B. Provide required materials, equipment, and facilities, including piping, cabling, controls, and appurtenances.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install temporary utilities and temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.
- B. Location of Temporary Utilities and Temporary Facilities:
 - 1. Locate temporary systems for proper function and service.
 - 2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility owners and others.
 - 3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.
- C. Modify and extend temporary systems as required by progress of the Work.

3.2 USE

- A. Maintain temporary systems to provide safe, continuous service as required.
- B. Properly supervise operation of temporary systems:
 - 1. Enforce compliance with Laws and Regulations.
 - 2. Enforce safe practices.
 - 3. Prevent abuse of services.
 - 4. Prevent nuisances and hazards caused by temporary systems and their use.
 - 5. Prevent damage to finishes.
 - 6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.
- C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient.

3.3 REMOVAL

- A. Completely remove temporary utilities, temporary facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.
- B. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner.

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

+ + END OF SECTION + +

SECTION 01 51 41

TEMPORARY PUMPING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes requirements for temporary pumping at facilities, such as treatment plants and pumping stations.
2. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals shown, specified, and required for temporary pumping and handling of fluids during the Project.
3. Design, provide, and maintain temporary pumping systems, including plugs, bulkheads, and line stops as required; pumps; piping, supports, and valves; temporary instrumentation and control systems; fuel and electricity; personnel; and appurtenances. Comply with Laws and Regulations and requirements of authorities having jurisdiction. System shall be suitable for its service and operating environment.
4. Required capacity of temporary pumping systems is specified in Section 01 14 16, Coordination with Owner's Operations. Provide temporary pumping system of required capacity with not less than the largest pump out of service.
5. Location of the temporary pumping system shall not affect OWNER's or facility manager's operations and access at the Site, and public access to streets and drives, unless approved by ENGINEER and authorities having jurisdiction.

B. Coordination:

1. Review installation procedures under other Sections and coordinate Work that will be performed with or before Work specified in this Section.

C. Related Sections:

1. Section 01 14 16, Coordination with Owner's Operations.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Temporary Pumping System Supplier:
 - a. Supplier shall have not less than five years of experience providing temporary pumping systems similar in size or larger than those required for the Project.
 - b. Upon request, submit evidence of providing not less than five temporary pumping systems on other projects similar in size (or larger)

and similar in service to temporary pumping systems required for the Project.

B. Component Supply and Compatibility:

1. Obtain each temporary pumping system from a single Supplier who shall be responsible for providing a complete system.

C. Regulatory Requirements:

1. Secondary containment for fuel tanks shall be in accordance with Laws and Regulations.
2. Leakage from temporary pumping system or improper discharge is not allowed.
3. Quality of exhaust emissions from internal-combustion engines associated with temporary pumping systems shall comply with Laws and Regulations, including applicable air permits. Before furnishing temporary pumping system, verify compliance with air quality standards and provide temporary emissions controls to comply with such standards when required.

1.3 SUBMITTALS

A. Timing: Furnish to ENGINEER submittals for temporary pumping system not less than 30 days prior to delivery of temporary pumping system to the Site.

B. Action Submittals: Submit the following:

1. Temporary Pumping System Submittal: Submit the following for each temporary pumping system:
 - a. System curve of flow plotted against total dynamic head, and calculations that substantiate the proposed temporary pumping system, including comparison of net positive suction head required and net positive suction head available.
 - b. Manufacturer's data and specifications on each type and size of pump proposed and its capacity, including pump curves.
 - c. Manufacturer's data and specifications for engines and other equipment required for temporary pumping system, including expected exhaust emissions data.
 - d. Technical information and specifications on noise controls for noise-emitting equipment.
 - d. Technical data on temporary piping, pipe joints, valves, pipe supports, controls, flow meter, secondary containment for fuel tanks, emissions controls when required, and other information pertinent to the temporary pumping system.
 - e. Layout Drawings:
 - 1) Sketches showing proposed layout of temporary pumping system, including locations of temporary plugs, bulkheads, and line stops; suction and discharge locations; location of pumps and associated piping and valves; and source of power for temporary pumping system. Sketches shall be scale drawings acceptable to ENGINEER,

and shall include site plans similar to those in the Contract Documents.

- 2) Details of system suction and discharge locations. Discharge details shall include measures to protect the receiving structure and dissipate energy.
 - 3) Where temporary lines will be buried, submit trench details. Submit sketches and information on other types of protection proposed for temporary piping.
- f. Temporary Plugs, Bulkheads, and Line Stops: Manufacturer's literature and fabrication drawings showing type of plug, bulkhead or line stop as applicable, materials, and hydrostatic head the plug, bulkhead, or line stop is designed to withstand. Submit complete technical information for CONTRACTOR-proposed line stops, installation procedures, name of proposed line stop installer, and documentation of experience on at least five similar projects.
 - g. Narrative describing proposed operation of temporary pumping system, including who will operate system, staffing, planned frequency of fueling, contingency plan in event of pump failure, and statement of existing systems that may be affected during operation of temporary pumping system.

C. Informational Submittals: Submit the following:

1. Schedule for Temporary Pumping for Facilities:
 - a. Schedule for each temporary pumping system. Include dates of mobilizing each temporary pumping system, testing, starting and ending dates of temporary pumping, and demobilizing each temporary pumping system.
 - b. At CONTRACTOR's option, such information may be included on the Progress Schedule prepared and maintained in accordance with Section 01 32 16, Progress Schedule. When such option is exercised, however, upon request of ENGINEER break out as separate sub-schedule the schedule of temporary pumping in collection system and furnish to ENGINEER.
 - c. Maintain and update schedule for temporary pumping for collection system, and submit updated schedules in accordance with requirements for updating the Progress Schedule as indicated in Section 01 32 16, Progress Schedule.
2. Qualifications Statements:
 - a. Qualifications of temporary pumping system Supplier.

PART 2 – PRODUCTS

2.1 TEMPORARY PUMPING SYSTEM

A. General:

1. System components shall be suitable for continuous operation with the fluid pumped.
 2. Noise Controls: Provide noise controls for temporary pumping system. Noise emitted from temporary pumping system shall comply with Laws and Regulations and shall not exceed 70 db at a distance of thirty feet from noise source.
 3. Fuel-consuming temporary pumping system components intended for use when CONTRACTOR is not present shall include fuel tanks sized for not less than 24 hours of uninterrupted operation at system's operating capacity, and means to automatically notify CONTRACTOR upon high and low suction water level and low fuel level.
- B. Instrumentation and Controls:
1. Provide temporary pumping system with flow meter acceptable to ENGINEER and suitable for pumped fluid, pipe material, and hydraulic conditions. Flow meter shall provide accurate flow measurement and include local display of flow rate in gallons per minute or million gallons per day as required, and be capable of providing 4 to 20 mA dc output signal for flow rate.
 2. Controls: Provide controls for temporary pumping system in accordance with Section 01 14 16, Coordination with Owner's Operations.
- C. Temporary Piping System:
1. Piping shall be steel, ductile iron, high density polyethylene, or other material accepted by ENGINEER, and suitable for system operating pressures. Aluminum piping and PVC piping not mechanically restrained are not allowed. Durable hoses can be used only for short sections and with acceptance by ENGINEER.
 2. Piping system shall have watertight joints of the following types: fused joints, restrained couplings, flanged coupling adapters, quick-connects by Camlok or equal, flanged joints, grooved and shouldered end-type couplings, and other watertight joints accepted by ENGINEER.
 3. Size discharge piping for flow velocity of not more than 10 feet per second.
 4. Provide check valves or approved pump control valves as required.
 5. Provide air valves on discharge piping as required. Air valves shall expel air upon pipe filling and admit air upon pipe dewatering, and release small quantities of entrained air during operation. Air valves shall be suitable for service with the pumped fluid.
 6. Discharge from temporary pumping system shall not adversely affect the existing process or facilities. Provide energy-dissipating measures at discharge point as necessary.
- D. Temporary Plugs, Bulkheads, and Line Stops:
1. Acceptable temporary plugs and bulkheads include inflatable dams specifically designed for such service, brick bulkheads, timber bulkheads, sandbags, and other bulkhead methods suitable for the service and conduit

conditions. Line stops, where required, are specified in Division 40 of the Contract Documents.

2. Each plug, temporary bulkhead, and line stop shall be suitable for the maximum pressure encountered.
3. Where temporary plugs and bulkheads are under pressure or surcharged, provide either two plugs or a plug and temporary bulkhead.

PART 3 – EXECUTION

3.1 PREPARATION

A. General:

1. Temporary piping shall be located off of roads, driveways, and sidewalks. Piping shall not be located in environmentally-sensitive areas such as wetlands.
2. Where required for OWNER's access to and operation of existing facilities, bury temporary piping that would otherwise inhibit access to processes, buildings, structures, streets, and driveways. In paved areas, provide temporary surfacing, sufficient for AASHTO H-20 wheel loads over buried temporary piping.
3. Hydrostatic Testing of Temporary Piping System:
 - a. Perform successful hydrostatic testing of temporary piping system using clean water at pressure equal to 1.2 times highest expected system operating pressure, for one hour while maintaining test pressure within 3.0 psig of required test pressure.
 - b. ENGINEER will witness hydrostatic test.
 - c. Hydrostatic test criteria for acceptance: No leakage.
4. Verify that entire temporary pumping system is ready for operation before commencing shutdown of OWNER's operations, facility, or systems. Verify that temporary pumping system controls and flow meter are properly connected and functional.

3.2 TEMPORARY PUMPING

A. During Operation of the Temporary Pumping System:

1. Temporary pumping system shall operate continuously. In the event of equipment failure, immediately make repairs or replace equipment. Provide spare parts and redundant units as necessary for continuous operation.
2. Provide personnel to monitor, operate, and maintain temporary pumping system twenty-four hours per day when system is in service.

3.3 DEMOBILIZATION

A. Upon Conclusion of Temporary Pumping:

1. Remove plugs, bulkheads, and line stops in manner that allows flow to slowly return to normal, without surging, surcharging, and adverse effects on existing system.
2. Flush out temporary pumping system with clean water discharged to an appropriate location.
3. Remove temporary pumping system and appurtenances from the Site.
4. When CONTRACTOR has obtained permit(s) for temporary pumping from authorities having jurisdiction, furnish written notice to such authorities that temporary pumping has been completed.

+ + END OF SECTION + +

SECTION 01 55 26

MAINTENANCE AND PROTECTION OF TRAFFIC

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall keep all roads, streets, and traffic ways open for passage of traffic and pedestrians during the Work, unless otherwise approved by owner of the street, traffic way, or right-of-way, as applicable.

B. Coordination:

1. Coordinate with owner of the highway or street right-of-way, as applicable, for maintenance and protection of traffic requirements.
2. Give required advance notice to fire departments, police departments, and other emergency services as applicable of proposed construction operations.
3. Give reasonable notice to owners or tenants of private property who may be affected by construction operations. Give such notice not less than 14 days prior to when such property will or may be affected by construction operations.
4. Coordinate with requirements of the following:
 - a. Section 01 71 33, Protection of the Work and Property, regarding temporary barriers.
 - b. Section 31 50 00, Excavation Support and Protection, for temporary barriers at excavations.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL PROVISIONS

- A. When required to cross, obstruct, or temporarily close a street or traffic way, provide and maintain suitable bridges, detours, or other acceptable temporary expedient for the accommodation of traffic. Closings shall be for shortest duration practical, and passage shall be restored immediately after completion of filling and temporary paving or bridging.

B. Temporary Control Devices:

1. Provide temporary signs, signals, barricades, flares, lights and other equipment, services, and personnel required to regulate and protect traffic and warn of hazards.

2. Such Work shall comply with requirements of OWNER and authorities having jurisdiction at the Site.
 3. Remove temporary equipment and facilities when no longer required, and restore grounds to condition indicated in the Contract Documents; if not indicated, resort to pre-construction conditions.
- C. Keep accessible for use permanent facilities such as hydrants, valves, fire alarm boxes, postal boxes, delivery service boxes, and other facilities that may require access during construction.

3.2 TRAFFIC SIGNALS AND SIGNS

- A. Provide and operate temporary traffic controls and directional signals required to direct and maintain an orderly flow of traffic in areas under CONTRACTOR's control, and areas affected by construction operations.
- B. Provide temporary traffic controls and directional signs, mounted on temporary barriers or standard posts, at the following locations:
1. Each change of direction of a roadway and at each crossroad.
 2. Detours and areas of hazard.
 3. Parking areas.
 4. Traffic entrance to and exit from each construction area.

3.3 TRAFFIC CONTROL PERSONNEL

- A. General:
1. When construction operations encroach on traffic lanes, furnish qualified and suitably-equipped traffic control personnel as required for regulating traffic and in accordance with requirements of authorities having jurisdiction.
 2. Traffic control personnel shall use appropriate flags or mobile signs.
 3. Equip traffic control personnel with appropriate personal protection equipment and suitable attire.
 4. Attire and conduct of traffic control personnel shall be appropriate and shall not create nuisances or distractions for traffic.

3.4 FLARES AND LIGHTS

- A. During periods of low visibility provide temporary flares and lights for the following:
1. To clearly delineate traffic lanes, to guide traffic, and to warn of hazardous areas.
 2. For use by traffic control personnel directing traffic.
- B. Provide adequate illumination of critical traffic and parking areas.

3.5 PARKING CONTROL

- A. Control CONTRACTOR-related vehicular parking at the Site to preclude interfering with: traffic and parking, access by emergency vehicles, OWNER's and facility manager's operations, and construction operations. Provide temporary parking facilities for the public, as required because of construction operations.
- B. Control parking of construction and private vehicles at the Site as follows:
 - 1. Maintain free vehicular access to and through parking areas.
 - 2. Prohibit parking on or adjacent to access roads, and in non-designated areas.
 - 3. Construction vehicles shall possess current vehicle registration.
 - 4. Private vehicles shall park only in designated areas.

3.6 HAUL ROUTES

- A. Submit proposed haul routes to ENGINEER and OWNER and obtain approval of authorities having jurisdiction.
- B. Confine construction traffic to designated haul routes.
- C. Provide temporary traffic controls at critical areas of haul routes to expedite traffic flow, and to minimize interference with normal traffic.

3.7 REMOVAL

- A. Maintain and protect traffic until Substantial Completion and at all times thereafter when CONTRACTOR is working at the Site. Provide maintenance and protection of traffic measures at the Site until no longer required due to the progress of the Work. When no longer required, completely remove maintenance and protection of traffic measures and restore the Site to condition required by the Contract Documents or, when not indicated in the Contract Documents, to pre-construction conditions.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 57 05

TEMPORARY CONTROLS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide and maintain methods, materials, equipment, and temporary construction as required for controlling environmental conditions at the Site and adjacent areas during construction.
2. Maintain controls until no longer required. Provide temporary controls at all times when CONTRACTOR is working at the Site.
3. Temporary controls include, but are not limited to, the following:
 - a. Erosion and sediment controls.
 - b. Noise controls.
 - c. Dust controls.
 - d. Pest and rodent controls.
 - e. Control of water, including storm water runoff.
 - f. Pollution controls.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable provisions and recommendations of the following:

1. State of Connecticut Department of Energy and Environmental Protection and the Town of Trumbull.

PART 2 – PRODUCTS

2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

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

PART 3 – EXECUTION

3.1 NOISE CONTROL

A. Noise Control – General:

1. CONTRACTOR's vehicles and equipment shall minimize noise emissions to greatest degree practicable. When necessary, provide mufflers and silencers on

- construction equipment, and provide temporary sound barriers onsite when necessary.
2. Noise levels shall comply with Laws and Regulations, including OSHA requirements and local ordinances.
 3. Noise emissions shall not interfere with the work of OWNER, facility manager, or others.

3.2 DUST CONTROL

- A. Dust Control – General:
 1. Control objectionable dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, demolition, cleaning, and other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of ENGINEER and approval of authorities having jurisdiction.
 2. CONTRACTOR shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce onsite and off-Site damage, nuisances, and health hazards associated with dust emissions.
- B. Dust Control Methods:
 1. Dust control may be achieved by irrigation in which the dust-prone area of the Site shall be sprinkled with water until the surface is moist.
 2. Apply dust controls as frequently as required without creating nuisances such as excessive mud and ponding of water at the Site. Do not use water for dust control when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
 3. Provide dust control that is non-polluting and does not contribute to tracking-out of dirt and dust onto pavement.
- C. Removal of Dust and Dirt from Travelled Surfaces:
 1. Remove dust and dirt from roadways, drives, parking areas, and other travelled surfaces not less than the frequency indicated in Section 01 74 05, Cleaning.
 2. Perform dust and dirt removals from travelled surfaces by mechanical sweeping or other method acceptable to ENGINEER.

3.3 PEST AND RODENT CONTROL

- A. Pest and Rodent Control – General:
 1. Provide pest and rodent controls as required to prevent infestation of the Site and storage areas.
 2. Employ methods and use materials that do not adversely affect conditions at the Site or on adjoining properties.
 3. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled.

3.4 WATER CONTROL

- A. Water Control – General:
 - 1. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, and adjoining properties.
 - 2. Control fill, grading, and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses to prevent erosion, damage, or nuisance. Avoid directing to adjoining properties runoff from the Site and construction operations.
- B. Equipment and Facilities for Water Control:
 - 1. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- C. Discharge and Disposal:
 - 1. Dispose of storm water and ground water in manner to prevent flooding, erosion, and other damage to any and all parts of the Site and adjoining areas, and that complies with Laws and Regulations.

3.5 POLLUTION CONTROL

- A. Pollution Control – General:
 - 1. Provide means, methods, and facilities required to prevent contamination of soil, water, and atmosphere caused by discharge of noxious substances from or caused by construction operations.
 - 2. Equipment used during construction shall comply with Laws and Regulations.
- B. Spills and Contamination:
 - 1. Provide equipment and personnel to perform emergency measures required to contain spills and to remove contaminated soils and liquids.
 - 2. Excavate contaminated material and properly dispose of off-Site, and replace with suitable compacted fill and topsoil.
- C. Protection of Surface Waters and Ground Water:
 - 1. Provide and maintain special measures to prevent harmful substances from entering surface waters and ground water. Prevent disposal of wastes, effluents, chemicals, and other such substances in or adjacent to surface waters and open drainage routes, in sanitary sewers, or in storm sewers, and in ground water.
- D. Atmospheric Pollutants:
 - 1. Provide and maintain systems for controlling atmospheric pollutants related to the Work.
 - 2. Prevent toxic concentrations of chemicals and vapors.
 - 3. Prevent harmful dispersal of pollutants into atmosphere.

- E. Solid Waste:
1. Provide and maintain systems for controlling and managing solid waste related to the Work.
 2. Prevent solid waste from becoming airborne, and from discharging to surface waters and drainage routes.
 3. Properly handle and dispose of solid waste.
 4. Comply with requirements for cleaning and disposal of debris in the General Conditions, as may be modified by the Supplementary Conditions, and Section 01 74 05, Cleaning.

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

1. General:
 - a. Provide temporary erosion and sediment controls as shown and indicated on the Drawings and as indicated elsewhere in the Contract Documents. Provide erosion and sediment controls as the Work progresses into previously-undisturbed areas.
 - b. Installation of erosion and sediment controls shall be in accordance with the applicable regulatory requirements indicated in Article 1.2 of this Section, unless more-stringent methods are otherwise shown or indicated in the Contract Documents.
 - c. Use necessary methods to successfully control erosion and sedimentation, including ecology-oriented construction practices, vegetative measures, and mechanical controls. Use best management practices (BMP) in accordance with Laws and Regulations, and regulatory requirements indicated in Article 1.2 of this Section, to control erosion and sedimentation during the Project.
 - d. Plan and execute construction, disturbances of soils and soil cover, and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation. Provide temporary measures for controlling erosion and sedimentation, as indicated in the Contract Documents and as required for the Project.
 - e. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provide measures for regulating drainage and controlling erosion and sedimentation, subject to the ENGINEER'S approval.
 - f. Provide erosion and sediment controls, including stabilization of soils, at the end of each workday.
2. Coordination:
 - a. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities and other Work to the extent necessary for economical, effective, and continuous erosion and sediment controls.
3. Before commencing activities that will disturb soil or soil cover at the Site, provide all erosion and sediment control measures required by the Contract Documents for the areas where soil or soil cover will be disturbed.

4. In general, implement construction procedures associated with, or that may affect, erosion and sediment control to ensure minimum damage to the environment during construction. CONTRACTOR shall implement any and all additional measures required to comply with Laws and Regulations.
5. Vegetation Removal: Remove only those shrubs, grasses, and other vegetation that must be removed for construction. Protect remaining vegetation.
6. Access Roads and Parking Areas: When possible, access roads and temporary roads and parking shall be located and constructed to avoid adverse effects on the environment. Provide measures to regulate drainage, avoid erosion and sedimentation, and minimize damage to vegetation.
7. Earthwork and Temporary Controls:
 - a. Perform excavation, fill, and related operations in accordance with Section 31 20 00, Earth Moving.
 - b. Control erosion to minimize transport of silt from the Site into existing waterways and surface waters. Such measures shall include, but are not limited to, using berms, silt fencing, baled straw silt barriers, gravel or crushed stone, mulching and soil stabilization, slope drains, and other methods. Apply such temporary measures to erodible materials exposed by activities associated with the construction of the Project.
 - c. Hold to a minimum the areas of bare soil exposed at one time.
 - d. Construct fills and waste areas by selectively placing fill and waste materials to eliminate surface silts and clays that will erode.
 - e. In performing earthwork, eliminate depressions that could serve as mosquito breeding pools.
 - f. CONTRACTOR shall provide special care in areas with steep slopes, where disturbance of vegetation shall be minimized to maintain soil stability.
8. Inspection and Maintenance:
 - a. Periodically inspect areas of earthwork and areas where soil or soil cover are disturbed to detect evidence of the start of erosion and sedimentation; promptly implement corrective measures as required to control erosion and sedimentation. Continue inspections and corrective measures until soils are permanently stabilized and permanent vegetation has been established
 - b. Inspect not less often than the frequency indicated in Section 01 41 26, Storm Water Pollution Prevention Plan and Permit.
 - c. Repair or replace damaged erosion and sediment controls within 24 hours of CONTRACTOR becoming aware of such damage.
 - d. Periodically remove silt and sediment that has accumulated in or behind sediment and erosion controls. Properly dispose of silt and sediment.
9. Duration of Erosion and Sediment Controls:
 - a. Maintain erosion and sediment controls in effective working condition until the associated drainage area has been permanently stabilized.
 - b. Maintain erosion and sediment controls until the Site is restored and site improvements including landscaping, if any, are complete with underlying soils permanently stabilized.

10. Work Stoppage:
 - a. If the Work is temporarily stopped or suspended for any reason, CONTRACTOR shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.
11. Failure to Provide Adequate Controls:
 - a. In the event CONTRACTOR repeatedly fails to satisfactorily control erosion and sedimentation, OWNER reserves the right to employ outside assistance or to use OWNER's own forces for erosion and sediment control.
 - b. Cost of such work by OWNER, plus engineering and inspection costs, will be deducted from amounts due CONTRACTOR, as set-offs in accordance with the Contract Documents.

B. Silt Fencing:

1. Install and maintain silt fencing in a vertical plane, at the location(s) shown or indicated in the Contract Documents and where required.
2. Locations of Silt Fencing:
 - a. Where possible, install silt fencing along contour lines so that each given run of silt fencing is at the same elevation.
 - b. On slopes, install silt fencing at intervals that do not exceed the maximum intervals indicated in the following table:

Slope (percent)	Maximum Length of Slope Above Each Silt Fence (feet)
2 and less	150
2.1 to 5	100
5.1 to 10	50
10.1 to 20	25
20.1 to 25	20
25.1 to 40	15
40.1 to 50	10

- c. Provide silt fencing around perimeter of each stockpile of topsoil, general fill material, and excavated material. Install silt fencing before expected precipitation and maintain until stockpile is removed.
 - d. Do not install silt fencing at the following types of locations:
 - 1) Area of concentrated storm water flows such as ditches, swales, or channels.
 - 2) Where rock or rocky soils prevent full and uniform anchoring of silt fencing.
 - 3) Across upstream or discharge ends of storm water piping or culverts.
3. Installation:
 - a. Securely fasten wire mesh to posts, and securely fasten filter cloth to wire mesh.

- b. When two sections of filter cloth abut each other, fold over edges and overlap by not less than six inches and securely fasten to wire mesh.
 - c. Embed posts in the ground to the depth necessary for proper controls; embed posts to not less than 16 inches below ground.
 - d. Filter cloth and wire mesh shall extend not less than eight inches below ground and not less than 16 inches above ground.
 - e. Remove sediment accumulated at silt fencing as required. Repair and reinstall silt fencing as required.
 - 4. Maintenance:
 - a. Do not allow formation of concentrated storm water flows on slopes above silt fencing unless so shown or indicated in the Contract Documents. If unauthorized concentrated storm water flows occur, stabilize the slope via earthmoving and other stabilization measures as required to prevent flow of concentrated storm water flows toward silt fencing.
- C. Straw Bale Dike.
- 1. Install straw bale dikes where shown or indicated, including in swales, along contours, and along toe of slopes.
 - 2. Install straw bales in shallow excavation as wide as the bale and approximately four to six inches below surrounding grade.
 - 3. Ends of straw bales shall tightly abut ends of adjacent straw bales.
 - 4. Securely install straw bales using two support posts per straw bale, driven into the ground not less than 1.5 to two feet below bottom of straw bale. Top of post shall be flush with top of straw bale. Angle first post for each straw bale toward the previously-installed straw bale.
 - 5. Frequently inspect straw bales and repair or replace as required. Remove accumulated silt and debris from behind straw bales.
- D. Mulching and Soil Stabilization:
- 1. Use mulching to temporarily stabilize exposed soil and fill material.
 - a. Immediately following final grading, provide mulch and stabilize with mats or netting, or sprayed soil stabilization emulsion with fiber additive.
 - b. Application of mulching for soil stabilization shall be as follows.
 - 1) Unrotted Straw or Salt Hay: 1.5 to two tons per acre.
 - 2) Soil stabilization emulsions, when used, shall be applied in accordance with manufacturer's instructions, and shall be applied with mulch or stabilization fibers.
 - 3) Wood-fiber or Paper-fiber Application: 1,500 lbs. per acre, installed by hydroseeding.
 - c. Where mats or netting are used:
 - 1) Cover entire area to be stabilized with mats or netting.
 - 2) Provide anchoring trenches at the top and bottom of slopes to receive mats or netting. Bury at least the top and bottom ends of mat or netting, four inches or more wide, at top and bottom of slope. Tamp

trench full of soil. Four inches from trench, secure mat or netting with appropriate staples spaced at intervals of 10 inches.

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

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

1. Protect each drainage inlet and catch basin that has the potential to receive storm water runoff from exposed soils, and does not discharge into a storm water settlement basin.
2. Install inlet filter bags inside of drainage inlet or catch basin in accordance with manufacturer's instructions. Secure inlet filter bag with the structure's grate or by other acceptable means.
3. Inlet filter bags shall not pose any obstruction above the pre-construction elevation of the drainage inlet or catch basin grate requiring barricades or flashers.
4. When removing silt and sediment from inlet filter bag, do not dump filter bag's contents into the drainage inlet or catch basin.
5. Remove silt and sediment from inlet filter bag, or replace inlet filter bag, when inlet filter bag is not more than half full.

F. Temporary Settlement Basin:

1. For constructing embankments comply with requirements in Division 31 Sections on earthwork, embankments, excavation, and fill.
2. Overflow Weir and Discharge Pipe:
 - a. Install piping in accordance with manufacturer's instructions.
 - b. Install overflow weirs at elevations shown or indicated on the Drawings or approved Shop Drawings, as applicable, to avoid overtopping and overfilling of settlement basin without short-circuiting the settlement basin's hydraulic performance.
 - c. Wrap and secure geotextile material specified for silt fencing around discharge structures of temporary settlement basins
3. Crushed Stone and Riprap: Install in accordance with Division 31 Sections on earthwork, fill, and riprap. Provide in areas of temporary settlement basin subject to erosion, and at upstream and downstream ends of discharge piping.
4. Remove sediment when required based on accumulation of material.
5. When temporary settlement basin is no longer required, remove the temporary settlement basin discharge weir, discharge piping, and spillway, fill the temporary settlement basin to required grade in accordance with requirements of Division 31 Section on excavation and fill, and provide landscaping in accordance with Division 32 Sections on landscaping.

G. Filter Bag on Dewatering Pump Discharge:

1. Provide dewatering of excavations in compliance with Division 31 Sections on earthmoving, excavation, and fill.
2. Locate filter bags and temporary pump discharge lines to avoid interfering with the public, use of private property, and OWNER's and facility manager's operations. Relocate filter bags and appurtenances when required.

3. Filter bag discharge shall be directed to appropriate storm water drainage route. Do not discharge into roadways, driveways, access roads, parking areas, or overland. When temporary settlement basin is used, locate filter bags to discharge to temporary settlement basin when practicable.
4. Provide filter bag on discharge of each dewatering pump drawing from an excavation.
5. Securely attach filter bag to pump discharge pipe or hose.
6. Maintain, clean out, and replace filter bags as required.

H. Temporary Stone Construction Entrance:

1. Where shown on the Drawings, and where construction vehicles will regularly transit to paved surfaces from unstabilized surfaces, provide temporary stone construction entrance. CONTRACTOR vehicles shall use temporary stone construction entrances.
2. Provide temporary stone construction entrances of the width, length, and thickness shown or indicated on the Drawings. When not shown or indicated on the Drawings, temporary stone construction entrance shall be not less than 50 feet long, by 20 feet wide, by eight inches deep.
3. Installation:
 - a. Ensure that subgrade under each temporary stone construction entrance is suitably dense for the intended purpose. Suitably prepare subgrade as required for temporary stone construction entrance.
 - b. Provide on subgrade a layer of geotextile separation fabric, installed in accordance with geotextile separation fabric manufacturer's recommendations for separation.
 - c. Provide stone on installed geotextile separation fabric. Grade the stone for passage of vehicles.
4. Maintenance:
 - a. Maintain temporary stone construction entrance at not less than the minimum required thickness. Add stone as required to maintain thickness.
 - b. When upper layer of temporary stone construction entrance becomes contaminated with soil, remove the contaminated material and replace with clean stone.
 - c. Using water to wash down temporary construction entrance or paved areas onto which soil material has been tracked is unacceptable.

3.7 REMOVAL OF TEMPORARY CONTROLS

A. Removals – General:

1. Upon completion of the Work, remove temporary controls and restore Site to specified condition; if condition is not specified, restore Site to pre-construction condition.
2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 57 33

SECURITY

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes general requirements for security at the Site, including accessing the Site, securing the Work, temporary fencing, and other requirements.
2. CONTRACTOR shall safely guard all the Work, the Project, materials, equipment, and property from loss, theft, damage, and vandalism until Substantial Completion, unless otherwise agreed upon by the parties.
3. CONTRACTOR's duty includes safely guarding OWNER's property in vicinity of the Work and Project, and other private property in the vicinity of the Project from injury and loss in connection with performance of the Project.
4. Costs for security required under this Section shall be paid by CONTRACTOR.
5. Make no claim against OWNER for damage resulting from trespass.
6. Remedy damage to property of OWNER and others arising from failure to furnish adequate security.
7. Provide temporary fencing in accordance with the Contract Documents.
8. CONTRACTOR's security measures shall be at least equal to those usually provided by OWNER or facility manager to protect existing facilities during normal operation.

1.2 CONTRACTOR'S SITE ACCESS AND SECURITY PROCEDURES

A. Comply with OWNER's security procedures and access restrictions at the Site throughout the Project. Comply with the following:

1. Personnel Identification:
 - a. All CONTRACTOR personnel, including Subcontractors, Suppliers, and others associated with the Project shall wear, at a visible location, at all times at the Site a durable, waterproof badge bearing CONTRACTOR's name, employer (if other than CONTRACTOR), and employee's name.
2. Parking:
 - a. Do not park outside of designated CONTRACTOR parking area, will be designated by the OWNER. Prepare and maintain parking area as required.
 - b. Personal vehicles are not allowed outside the contractor parking area.

PART 2 – PRODUCTS

2.1 TEMPORARY FENCING

- A. Erect and maintain temporary fencing as required, and at locations where permanent security fencing or barriers are breached or temporarily removed for the Work.

PART 3 – EXECUTION

3.1 TEMPORARY FENCING

- A. Installation:
 - 1. Provide temporary fencing for site security so that integrity of site security is maintained throughout the Project.
 - 2. Install temporary fencing used for site security in accordance with the Contract Documents and fence manufacturer's instructions.
- B. Maintenance:
 - 1. Maintain temporary fencing throughout the Project.
 - 2. Repair damage to temporary fencing and replace fencing when required to preserve Site security.
- C. Removal:
 - 1. Remove temporary fencing when permanent site security fencing is in place and fully functional, or when otherwise directed or ENGINEER.

+ + END OF SECTION + +

SECTION 01 62 00

PRODUCT OPTIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. This Section includes:
 - a. CONTRACTOR's options for selecting materials and equipment.
 - b. Requirements for consideration of "or-equal" materials and equipment.

1.2 PRODUCT OPTIONS

- A. For materials and equipment specified only by reference standard or description, without reference to Supplier, furnish materials and equipment complying with such standard, by a Supplier or from a source that complies with the Contract Documents.
- B. For materials and equipment specified by naming one or more items or Suppliers, furnish the named materials and equipment that comply with the Contract Documents, unless an "or-equal" or substitute item is approved by ENGINEER.
- C. For materials and equipment specified by naming one or more items or Suppliers and the term, "or-equal", when CONTRACTOR proposes a material or equipment item or Supplier as an "or-equal", submit to ENGINEER a request for approval of an "or-equal" item or Supplier.
- D. For materials and equipment specified by naming only one item or manufacturer and followed by words indicating that no substitution is allowed, there is no option and no "or-equals" or substitution will be allowed or approved.

1.3 "OR-EQUAL" ITEMS

- A. Procedure:
 - 1. For proposed materials and equipment not named in the Contract Documents and considered as an "or-equal" in accordance with the General Conditions, CONTRACTOR shall request in writing ENGINEER's approval of the "or-equal".
 - 2. Request for approval of an "or-equal" item shall accompany the Shop Drawing or product data submittal for the proposed item
- B. Requests for approval of "or-equals" shall include:

1. CONTRACTOR's written request that the proposed item be considered as an "or-equal" in accordance with the General Conditions, accompanied by CONTRACTOR's certifications required in the General Conditions.
2. Documentation adequate to demonstrate to ENGINEER that proposed item does not require extensive revisions to the Contract Documents, that proposed item is consistent with the Contract Documents, and that proposed item will produce results and performance required in the Contract Documents, and that proposed item is compatible with other portions of the Work.
3. Detailed comparison of significant qualities of proposed item with the materials and equipment and manufacturers named in the Contract Documents. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements shown or indicated.
4. Evidence that proposed item's manufacturer will furnish warranty equal to or better than that specified, if any.
5. List of similar installations for completed projects with project names and addresses, and names and address of design professionals and owners, when requested.
6. Samples, when requested by ENGINEER.
7. Other information requested by ENGINEER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 65 00

PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes general requirements for preparing for shipping, delivering, and handling materials and equipment to be incorporated into the Work.
2. CONTRACTOR shall make all arrangements for transporting, delivering, and handling of materials and equipment required for prosecution and completion of the Work.
3. When required, move stored materials and equipment without changes to the Contract Price or Contract Times.

1.2 SUBMITTALS

- A. Refer to individual Specifications Sections for submittal requirements relative to delivering and handling materials and equipment.

1.3 PREPARING FOR SHIPMENT

- A. When practical, factory-assemble materials and equipment. Mark or tag separate parts and assemblies to facilitate field-assembly. Cover machined and unpainted parts that may be damaged by the elements or climate with strippable, protective coating.
- B. Package materials and equipment to facilitate handling, and protect materials and equipment from damage during shipping, handling, and storage. Mark or tag outside of each package and crate to indicate the associated purchase order number, bill of lading number, contents by name, OWNER's contract designation, CONTRACTOR name, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.
- C. Protect materials and equipment from exposure to the elements and damage by climate, and keep thoroughly dry and dust-free at all times. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Lubricate bearings and other items requiring lubrication in accordance with manufacturer's instructions.
- D. Advance Notification of Shipments:

1. Keep ENGINEER informed of delivery of all materials and equipment to be incorporated in the Work.
- E. Do not ship materials and equipment until:
1. Related Shop Drawings, Samples, and other submittals required by the Contract Documents have been approved or accepted (as applicable) by ENGINEER, including, but not necessarily limited to, all Action Submittals associated with the materials and equipment being delivered.
 2. Manufacturer's instructions for handling, storing, and installing the associated materials and equipment have been submitted to and accepted by ENGINEER in accordance with the Specifications.
 3. Results of source quality control testing (factory testing), when required by the Contract Documents for the associated materials or equipment, have been submitted to and accepted by ENGINEER.
 4. Facilities required for handling materials and equipment in accordance with the Contract Documents and manufacturer's instructions are in place and available.
 5. Required storage facilities have been provided.

1.4 DELIVERY

- A. Scheduling and Timing of Deliveries:
1. Arrange deliveries of materials and equipment in accordance with the Progress Schedule accepted by ENGINEER and in ample time to facilitate inspection and observation prior to installation.
 2. Schedule deliveries to minimize space required for and duration of storage of materials and equipment at the Site or other delivery location, as applicable.
 3. Coordinate deliveries to avoid conflicting with the Work and conditions at Site, and to accommodate the following:
 - a. Work of other contractors and OWNER.
 - b. Storage space limitations.
 - c. Availability of equipment and personnel for handling materials and equipment.
 - d. OWNER's use of premises.
 4. Deliver materials and equipment to the Site during regular working hours.
 5. Deliver materials and equipment to avoid delaying the Work and the Project, including work of other contractors, as applicable. Deliver anchor system materials, including anchor bolts to be embedded in concrete or masonry, in ample time to avoid delaying the Work.
- B. Deliveries:
1. Shipments shall be delivered with CONTRACTOR's name, Subcontractor's name (if applicable), Site name, Project name, and contract designation clearly marked.

2. Site may be listed as the “ship to” or “delivery” address; but OWNER shall not be listed as recipient of shipment unless otherwise directed in writing by ENGINEER.
 3. Provide CONTRACTOR’s telephone number to shipper; do not provide OWNER’s telephone number.
 4. Arrange for deliveries while CONTRACTOR’s personnel are at the Site. CONTRACTOR shall receive and coordinate shipments upon delivery. Shipments delivered to the Site when CONTRACTOR is not present will be refused by OWNER, and CONTRACTOR shall be responsible for the associated delays and additional costs, if incurred.
- C. Containers and Marking:
1. Have materials and equipment delivered in manufacturer’s original, unopened, labeled containers.
 2. Clearly mark partial deliveries of component parts of materials and equipment to identify materials and equipment, to allow easy accumulation of parts, and to facilitate assembly.
- D. Inspection of Deliveries:
1. Immediately upon delivery, inspect shipment to verify that:
 - a. Materials and equipment comply with the Contract Documents and approved or accepted (as applicable) submittals.
 - b. Quantities are correct.
 - c. Materials and equipment are undamaged and of the required quality.
 - d. Containers and packages are intact and labels are legible.
 - e. Materials and equipment are properly protected.
 2. Promptly remove damaged materials and equipment from the Site and expedite delivery of new, undamaged materials and equipment, and remedy incomplete or lost materials and equipment. Furnish materials and equipment in accordance with the Contract Documents, to avoid delaying progress of the Work.
 3. Advise ENGINEER in writing when damaged, incomplete, or defective materials and equipment are delivered, and advise ENGINEER of the associated impact on the Progress Schedule.

1.5 HANDLING OF MATERIALS AND EQUIPMENT

- A. Provide equipment and personnel necessary to handle materials and equipment, including those furnished by OWNER, by methods that prevent soiling or damaging materials and equipment and packaging.
- B. Provide additional protection during handling as necessary to prevent scraping, marring, and otherwise damaging materials and equipment and surrounding surfaces.

- C. Handle materials and equipment by methods that prevent bending and overstressing.
- D. Lift heavy components only at designated lifting points.
- E. Handle materials and equipment in safe manner and as recommended by the manufacturer to prevent damage. Do not drop, roll, or skid materials and equipment off delivery vehicles or at other times during handling. Hand-carry or use suitable handling equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. This Section includes general requirements for storing and protecting materials and equipment.
 - 2. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals to store and handle materials and equipment to be incorporated into the Work, and other materials and equipment at the Site.

1.2 STORAGE

- A. Store and protect materials and equipment in accordance with manufacturer's recommendations and the Contract Documents.
- B. General:
 - 1. CONTRACTOR shall make all arrangements and provisions necessary for, and pay all costs for, storing materials and equipment.
 - 2. Excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed to avoid injuring the Work and existing facilities and property, and so that free access is maintained at all times to all parts of the Work and to public utility installations in vicinity of the Work.
 - 3. Store materials and equipment neatly and compactly in locations that cause minimum inconvenience to OWNER, facility manager, other contractors, public travel, and owners, tenants, and occupants of adjoining property.
 - 4. Arrange storage in manner to allow easy access for inspection by ENGINEER and Resident Project Representative (RPR).
- C. Storage Location:
 - 1. Restrictions:
 - a. Do not store materials or equipment in structures being constructed unless approved by ENGINEER in writing.
 - b. Do not use lawns or other private property for storage without written permission of the owner or other person in possession or control of such premises.
- D. Protection of Stored Materials:
 - 1. Store materials and equipment to become OWNER's property to ensure preservation of quality and fitness of the Work, including proper protection

against damage by freezing, moisture, and with outdoor ambient air high temperatures as high as 100 degrees F; temperature and humidity inside crates, containers, storage sheds, and packaging may be significantly higher than the outdoor ambient air temperature.

2. Store in indoor, climate-controlled storage areas all materials and equipment subject to damage by moisture, humidity, heat, cold, and other elements, unless otherwise acceptable to OWNER.
3. When placing orders to Suppliers for equipment and controls containing computer chips, electronics, and solid-state devices, CONTRACTOR shall obtain, coordinate, and comply with specific temperature and humidity limitations on materials and equipment, because temperature inside cabinets and components stored in warm temperatures can approach 200 degrees F.
4. CONTRACTOR shall be fully responsible for loss or damage (including theft) to stored materials and equipment.
5. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer or otherwise specified in the Contract Documents.
6. Comply with requirements of Article 1.3 of this Section.

1.3 PROTECTION – GENERAL

- A. Equipment to be incorporated into the Work shall be boxed, crated, or otherwise completely enclosed and protected during shipping, handling, and storage, in accordance with Section 01 65 00, Product Delivery Requirements.
- B. Store all materials and equipment off the ground (or floor) on raised supports such as skids or pallets.
- C. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Painted equipment surfaces that are damaged or marred shall be repainted in their entirety in accordance with equipment manufacturer and paint manufacturer requirements, to the satisfaction of ENGINEER.
- D. Protect electrical equipment, controls, and instrumentation against moisture, water damage, humidity, heat, cold, and dust. Space heaters provided in equipment shall be connected and operating at all times until equipment is placed in operation and permanently connected.

1.4 UNCOVERED STORAGE

- A. The following types of materials may be stored outdoors without cover on supports so there is no contact with the ground:
 1. Reinforcing steel.
 2. Precast concrete materials.
 3. Structural steel.
 4. Metal stairs.

5. Handrails and railings.
6. Grating.
7. Checker plate.
8. Metal access hatches.
9. Castings.
10. Fiberglass items.
11. Rigid electrical conduit, except PVC-coated conduit.
12. Piping, except PVC or chlorinated PVC (CPVC) pipe.

1.5 COVERED STORAGE

- A. The following materials and equipment may be stored outdoors on supports and completely covered with covering impervious to water:
 1. Grout and mortar materials.
 2. Masonry units.
 3. Rough lumber.
 4. Soil materials and granular materials such as aggregate.
 5. PVC and CPVC pipe.
 6. PVC-coated electrical conduit.
 7. Filter media.
- B. Tie down covers with rope, and install covering properly sloped to prevent accumulation of water.
- C. Store loose granular materials, with covering impervious to water, in well-drained area or on solid surfaces to prevent mixing with foreign matter.

1.6 FULLY PROTECTED STORAGE

- A. Store all material and equipment not indicated in Articles 1.4 and 1.5 of this Section on supports in buildings or trailers that have concrete or wooden flooring, roof, and fully-closed walls on all sides. Covering with visquine plastic sheeting or similar material in space without floor, roof, and walls is unacceptable. Comply with the following:
 1. Provide heated storage for materials and equipment that could be damaged by low temperatures or freezing.
 2. Provide air-conditioned storage for materials and equipment that could be damaged by high temperatures or humidity.
 3. Protect mechanical and electrical equipment from being contaminated by dust, dirt, and moisture.
 4. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

1.7 HAZARDOUS MATERIALS AND EQUIPMENT

- A. Prevent contamination of personnel, storage areas, and the Site. Comply with Laws

and Regulations, manufacturer's instructions, and other provisions of the Contract Documents.

1.8 MAINTENANCE OF STORAGE

- A. On a scheduled basis, periodically inspect stored materials and equipment to ensure that:
 - 1. Condition and status of storage facilities is adequate to provide required storage conditions.
 - 2. Required environmental conditions are maintained on continuing basis.
 - 3. Materials and equipment exposed to elements are not adversely affected.
- B. Mechanical and Electrical Equipment in Long-Term Storage:
 - 1. Mechanical and electrical equipment requiring long-term storage shall have complete manufacturer's instructions for servicing each item, with notice of enclosed instructions shown on exterior of container or packaging.
 - 2. Comply with manufacturer's instructions on scheduled basis.
 - 3. Space heaters that are part of electrical equipment shall be connected and operated continuously until equipment is placed in service and permanently connected.
 - 4. Affidavits:
 - 1. Submit to ENGINEER affidavit for each time that maintenance and inspection was performed on materials and equipment in long-term storage. Affidavit shall be signed by CONTRACTOR and entity performing the inspection and maintenance on the stored items.
 - 2. Affidavit shall indicate the date of the inspection, personnel and employer of each involved, specific stored items inspected, equipment condition, problems observed, problems corrected, maintenance tasks performed, conditions of storage environment, and other pertinent information.
 - 3. Affidavit shall include signed statement by the manufacturer of the item(s) indicating whether the storage conditions and tasks performed are suitable for continued compliance with manufacturer's warranties.

1.9 MICROPROCESSORS, PANELS, AND INSTRUMENTATION STORAGE

- A. Store control panels, microprocessor-based equipment, electronics, and other devices subject to damage or decreased useful life because of temperatures below 40 degrees F or above 100 degrees F, relative humidity above 90 percent, or exposure to rain or exposure to blowing dust in climate-controlled storage space.
- B. General:
 - 1. Storage shall be in a third-party owned, bonded, insured, climate-controlled warehouse in Connecticut.
 - 2. OWNER and ENGINEER have the right to observe or inspect materials and equipment during normal working hours.

3. Place inside each control panel or device a desiccant, volatile corrosion inhibitor blocks (VCI), moisture indicator, and maximum-minimum indicating thermometer.
 4. Check panels and equipment not less than once per month. Replace desiccant, VCI, and moisture indicator as often as required, or every six months, whichever occurs first.
 5. Certified record of daily maximum and minimum temperature and humidity in storage facility shall be available for inspection by OWNER and ENGINEER. Certified record of monthly inspection, noting maximum and minimum temperature for month, condition of desiccant, VCI, and moisture indicator, shall be made available to OWNER and ENGINEER upon request.
- C. Costs for storing climate-sensitive materials and equipment shall be paid by CONTRACTOR. Replace panels and devices damaged during storage, or for which storage temperatures or humidity range has been exceeded, at no additional cost to OWNER. Delays resulting from such replacement are causes within CONTRACTOR's control.
- D. Do not ship control panels and equipment to the Site until conditions at the Site are suitable for installation, including slabs and floors, walls, roofs, and environmental controls. Failure to have the Site ready for installation shall not relieve CONTRACTOR from complying with the Contract Documents.

1.10 RECORDS

- A. Keep up-to-date account of materials and equipment in storage to facilitate preparation of Applications for Payment, if the Contract Documents provide for payment for materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 71 23

FIELD ENGINEERING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes field engineering, surveying, and layouts by CONTRACTOR, and associated requirements. This Section supplements the General Conditions' provisions on reference points and other matters.
2. CONTRACTOR shall provide field engineering services, surveying and layout services, and professional services of the types indicated for the Project, including:
 - a. Furnishing civil, structural, and other professional engineering services specified or required to execute CONTRACTOR's construction methods.
 - b. Developing and making all detail surveys and measurements required for construction; including slope stakes, batter boards, and all other working lines, elevations, and cut sheets.
 - c. Providing materials required for benchmarks, control points, batter boards, grade stakes, structure and pipeline elevation stakes, and other items.
 - d. Keeping a transit, theodolite, or total station (i.e., theodolite with electronic distance measurement device); leveling instrument; and related implements such as survey rods and other measurement devices, at the Site at all times, and having a skilled instrument person available when necessary for laying out the Work.
 - e. Being solely responsible for all locations, dimensions and levels. No data other than Change Order, Work Change Directive, or Field Order shall justify departure from dimensions and levels required by the Contract Documents.
 - f. Rectifying all Work improperly installed because of not maintaining, not protecting, or removing without authorization established reference points, stakes, marks, and monuments.
 - g. Providing such facilities and assistance necessary for ENGINEER and Resident Project Representative (if any) or Owner's Site Representative (if any) to check lines and grade points placed by CONTRACTOR. Do not perform excavation or embankment work until all cross-sectioning necessary for determining payment quantities for Unit Price Work have been completed and accepted by ENGINEER.

B. Coordination:

1. Review requirements of this and other Sections and coordinate installation of items to be installed with or before field engineering, surveying, and layout Work.

1.2 CONTRACTOR'S SURVEYOR

A. Qualifications:

1. Employ or retain the services, as needed, at the Site a surveyor with experience and capability of performing surveying and layout tasks required in the Contract Documents and as required for the Work.
2. CONTRACTOR's surveyor shall possess not less than five years of experience performing duties similar in scope and extent to those required of CONTRACTOR's surveyor on this Project.

B. Responsibilities of Contractor's Surveyor:

1. Providing required surveying equipment, including transit, theodolite, or total station; level; stakes; and surveying accessories.
2. Establishing required lines and grades for constructing all facilities, structures, pipelines, and site improvements, including outdoor electrical equipment and feeders.
3. Preparing and maintaining professional-quality, accurate, well-organized, legible notes of all measurements and calculations made while surveying and laying out the Work.
4. Prior to backfilling operations, survey, locate, and record on a copy of the Contract Documents accurate representation of buried Work and Underground Facilities provided and encountered.
5. Locating on a site plan of the Site the actual location of above-ground Work to be indicated on record documents.
6. Complying with requirements of the Contract Documents relative to surveying and related Work, including requirements of this Section's Articles 1.5 and 3.1.

1.3 RECORDS

A. Records – General:

1. Maintain at the Site a complete and accurate log of control and survey Work as such Work progresses.

B. Field Books and Records:

1. Survey data and records shall be in accordance with recognized professional surveying standards, Laws and Regulations, and prevailing standards of practice in the locality where the Site is located.
2. Original field notes, computations, and other surveying data shall be recorded by CONTRACTOR's surveyor in CONTRACTOR-furnished hard-bound field books.

3. Completeness and accuracy of survey Work, and completeness and accuracy of survey records, including field books, shall be responsibility of CONTRACTOR.
4. Failure to organize and maintain survey records in an appropriate manner that allows reasonable and independent verification of calculations, and to allow identification of elevations, dimensions, and grades of the Work, shall be cause for rejecting the survey records, including field books.
5. Illegible notes or data, and erasures on any page of field books, are unacceptable. Do not submit copied notes or data. Corrections by ruling or lining out errors will be unacceptable unless initialed by the surveyor. Violation of these requirements may require re-surveying the data questioned by ENGINEER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SURVEYING

A. Reference Points:

1. Refer the General Conditions, as may be modified by the Supplementary Conditions, for requirements regarding reference points.
2. OWNER's established reference points that are damaged or destroyed by CONTRACTOR will be re-established by OWNER at CONTRACTOR's expense. OWNER may deduct from payments owed CONTRACTOR such amounts as set-offs in accordance with the Contract Documents.
3. From OWNER-established reference points, establish lines, grades, and elevations necessary to control the Work. Obtain measurements required for executing the Work to tolerances specified in the Contract Documents.
4. Establish, place, and replace as required, such additional stakes, markers, and other reference points necessary for control, intermediate checks, and guidance of construction operations.

B. Surveys to Determine Quantities for Payment:

1. For each application for progress payment, perform such surveys and computations necessary to determine quantities of Work performed or placed. Perform surveys necessary for ENGINEER to determine final quantities of Work in place.
2. Notify ENGINEER not less than 24 hours before performing survey services for determining quantities to be included in Application for Payment. Unless waived in writing by ENGINEER, perform quantity surveys in presence of ENGINEER or Resident Project Representative (if any).

C. Construction Surveying: Comply with the following:

1. Alignment Staking: Provide alignment stakes at 50-foot intervals on tangent, and at 25-foot intervals on curves.
2. Slope Staking: Provide slope staking at 50-foot intervals on tangent, and at 25-foot intervals on curves. Re-stake at every ten-foot difference in elevation.
3. Structure: Stake-out structures, including elevations, and check prior to and during construction.
4. Pipelines: Stake-out pipelines including elevations, and check prior to and during construction.
5. Roads, Drives, and Paved Areas: Stake-out roadway, driveway, and paved area elevations at 50-foot intervals on tangent, and at 25-foot intervals on curves.
6. Cross-sections: Provide original, intermediate, and final staking as required, for site work other locations as necessary for quantity surveys.
7. Easement Staking: Provide easement staking at 50-foot intervals on tangent, and at 25-foot intervals on curves. Also provide wooden laths with flagging at maximum intervals of 100 feet.
8. Record Staking: Provide permanent stake at each blind flange and each utility cap provided for future connections. Stakes for record staking shall be material acceptable to ENGINEER.

D. Accuracy:

1. Establish CONTRACTOR's temporary survey references points for CONTRACTOR's use to not greater than second-order accuracy (e.g., 1:10000). Construction staking used as a guide for the Work shall be set at not greater than third-order accuracy (e.g., 1:5000). Basis on which such orders are established shall provide the absolute margin for error specified below.
2. Horizontal accuracy of easement staking shall be plus or minus 0.1 feet. Accuracy of other staking shall be plus or minus 0.04 feet horizontally and plus or minus 0.02 feet vertically.
3. Survey calculations shall include an error analysis sufficient to demonstrate required accuracy.

+ + END OF SECTION + +

SECTION 01 71 33

PROTECTION OF THE WORK AND PROPERTY

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes general requirements for safety and protection that augment the requirements of the General Conditions, as may be modified by the Supplementary Conditions. This Section also includes requirements for barricades and warning signals, and protection of trees and plants, existing structures, floors, roofs, installed items, and landscaping.
2. CONTRACTOR shall be responsible for taking all precautions, providing all programs, and taking all actions necessary to protect personnel health and safety, and to protect the Work and all public and private property and facilities from damage, as specified in the General Conditions, Supplementary Conditions, and the Specifications.
3. To prevent damage, injury, or loss, CONTRACTOR's actions shall include the following:
 - a. Provide measures for safety of personnel at the Site, including workers engaged in the Work, delivery personnel, testing and inspection personnel, personnel of authorities having jurisdiction, other visitors to the Site, the public, OWNER's personnel, facility manager's personnel (if different from OWNER), ENGINEER, and Resident Project Representative (if any).
 - b. Storing apparatus, materials, supplies, and equipment in an orderly, safe manner that does not unduly interfere with progress of the Work or work of other contractors, utility owners, and owners of transportation rights-of-way.
 - c. Providing suitable storage facilities for materials and equipment subject to damage or degradation by exposure to climate, temperature, theft, breakage, or other cause.
 - d. Placing upon the Work or any part thereof only loads consistent with the safety and integrity of that portion of the Work and existing construction.
 - e. Frequently removing and disposing of refuse, rubbish, scrap materials, and debris caused by CONTRACTOR's operations so that, at all times, the Site is safe, orderly, and workmanlike in appearance.
 - f. Providing temporary barricades, fencing, and guard rails around the following: openings, scaffolding, temporary stairs and ramps, around excavations, for elevated walkways, and other areas that may present a fall-hazard or hazard to vehicles.

4. Do not, except after written consent from proper parties, enter or occupy privately-owned property or premises with personnel, tools, materials or equipment, except on lands and easements provided by OWNER.
5. CONTRACTOR has full responsibility for preserving public and private property and facilities on and adjacent to the Site. Direct or indirect damage done by, or on account of, any act, omission, neglect, or misconduct by CONTRACTOR in executing the Work, shall be remedied by CONTRACTOR, at his expense, to condition equal to that existing before damage was done.
6. Owner May Remedy:
 - a. Should CONTRACTOR fail to protect and safeguard property and the Work after requests from ENGINEER or OWNER, OWNER may implement measures to protect property and the Work.
 - b. Cost of such OWNER-implemented measures shall be paid by CONTRACTOR. OWNER may deduct from payments due CONTRACTOR such amounts as set-offs in accordance with the Contract Documents.
 - c. Such right, however, shall not result in any obligation by OWNER or ENGINEER to continuously monitor or have responsibility for protection of property and the Work, which responsibility is exclusively CONTRACTOR's.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 BARRICADES AND WARNING SIGNALS

- A. Barricades and Warning Signals – General:
 1. Where the Work is performed on or adjacent to roadway, access road or driveway, right-of-way, or public place:
 - a. Provide temporary barricades, fences, lights, warning signs, danger signals, watchmen, and take other precautionary measures for protecting persons, property, and the Work.
 - b. Use appropriately colored and reflective barricades, or paint barricades accordingly, to be visible at night.
 - c. From sunset to sunrise, provide and maintain not less than one temporary light at each barricade.
 - d. Erect sufficient barricades to keep vehicles from being driven on or into Work under construction.
 - e. Furnish watchmen in sufficient numbers to protect the Work.
 2. Provide temporary barricades to protect personnel and property for Work not in or adjacent to transportation routes and vehicular travel areas, including indoor work, in accordance with Laws and Regulations.

3. CONTRACTOR's responsibility for maintaining temporary barricades, signs, lights, and for providing watchmen shall continue until the Work is substantially complete in accordance with the Contract Documents, unless other provision for security and protection is agreed to by the parties. After Substantial Completion, protect Work and property during periods when final Work or corrective Work is underway.

B. Temporary Fencing: Refer to Section 01 57 33, Security.

3.2 TREE AND PLANT PROTECTION

A. Tree and Plant Protection – General:

1. Protect existing trees, shrubs, and plants on or adjacent to the Site, shown or designated to remain in place, against unnecessary cutting, breaking, damage, or skinning of trunk, branches, bark, and roots.
2. Do not store materials or equipment or park construction equipment and vehicles within foliage drip lines.
3. In areas subject to traffic, provide temporary fencing or temporary barricades to protect trees and plants.
4. Open fires are not allowed onsite.
5. Within the limits of the Work, water trees and plants that are to remain to maintain their health during construction operations.
6. Cover exposed roots with burlap, and keep such burlap continuously wet. Cover exposed roots with earth as soon as possible. Protect root systems from mechanical damage and damage by erosion, flooding, runoff, and noxious materials in solution.
7. If branches or trunks are damaged, prune branches immediately and protect cut or damaged areas with emulsified asphalt compounded specifically for horticultural use, in manner acceptable to ENGINEER.
8. When directed by ENGINEER, remove and dispose of at location away from the Site damaged trees and plants that die or suffer permanent injury, and replace each damaged tree or plant with specimen of equal or better species and quality.

3.3 PROTECTION OF EXISTING STRUCTURES

A. Underground Facilities:

1. Underground Facilities known to OWNER and ENGINEER, except water, gas, sewer, electric, and communications services to individual buildings and properties, are shown. Information shown for Underground Facilities is the best available to OWNER and ENGINEER but, in accordance with the General Conditions, as may be modified by the Supplementary Conditions, is not guaranteed to be correct or complete.

2. CONTRACTOR shall explore ahead of trenching and excavating Work and shall sufficiently uncover Underground Facilities that will or may interfere with the Work to determine their location, to prevent damage to Underground Facilities, and to prevent service interruption to structures and properties served by Underground Facilities. If CONTRACTOR damages an Underground Facility, CONTRACTOR shall restore it to its pre-construction condition, in accordance with requirements of the owner of the damaged facility and the Contract Documents.
3. Necessary changes in the location of the Work may be directed by ENGINEER to avoid Underground Facilities not shown or indicated on the Contract Documents.
4. If permanent relocation of an existing Underground Facilities is required and is not otherwise shown or indicated in the Contract Documents, CONTRACTOR may be directed in writing to perform the required work. When such relocation Work results in a change in the Contract Price, Contract Times, the associated Contract modification procedures and payment for such Work shall be in accordance with the Contract Documents.

B. Surface Structures:

1. Surface structures are existing buildings, structures, and other facilities at or above ground surface, including their foundations and any extension below ground surface. Surface structures include, but are not limited to, buildings, tanks, walls, bridges, roads, dams, channels, open drainage routes, exposed piping and utilities, poles, exposed wires, posts, signs, markers, curbs, walks, fencing, and other facilities visible at or above ground surface.
2. Existing surface facilities, including but not limited to guard rails, posts, guard cables, signs, poles, markers, curbs, and fencing, that are temporarily removed to facilitate the Work shall be replaced and restored to their pre-construction condition at CONTRACTOR's expense.

C. Protection of Underground Facilities and Surface Structures:

1. CONTRACTOR shall sustain in their places and protect from direct or indirect injury all Underground Facilities and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure or facility.
2. Before proceeding with the Work of sustaining and supporting such structure or facility, CONTRACTOR shall satisfy ENGINEER that methods and procedures to be used have been approved by party owning same.
3. CONTRACTOR shall bear all risks attending the presence or proximity of all Underground Facilities and surface structures within or adjacent to limits of the Work, in accordance with the Contract Documents.

4. CONTRACTOR shall be responsible for damage and expense for direct or indirect injury, caused by CONTRACTOR's activities, to structures and facilities. CONTRACTOR shall promptly repair damage caused by CONTRACTOR's activities, to the satisfaction of owner of damaged structure or facility.
5. Protection of Underground Facilities Under Roads and Parking Areas: Provide temporary, heavy-duty steel roadway plates to protect existing manholes, handholes, valve boxes, vaults, and other Underground Facilities near to or visible at the ground surface.

3.4 PROTECTION OF FLOORS AND ROOFS

- A. Protection of Floors and Roofs – General:
 1. Use proper protective covering when moving equipment, handling materials or other loads, when painting, handling mortar or grout, and when cleaning walls, ceilings, or structure contents.
 2. Use metal pans to collect oil and cuttings from piping, conduits, and rod threading machines, and under metal cutting machines.
 3. Do not load concrete floors less than 28 days old without written permission of ENGINEER. Do not load floors, roofs, or slabs in excess of design loading.
 4. Do not load roofs without written permission of ENGINEER.
 5. Restrict access to roofs, and keep CONTRACTOR personnel off existing roofs, except as required for the Work.
 6. If access to roofs is required, roofing, parapets, openings, and all other construction on or adjacent to roof shall be protected with suitable plywood or other acceptable means.

3.5 PROTECTION OF INSTALLED MATERIALS, EQUIPMENT, AND LANDSCAPING

- A. Protect installed Work to prevent damage from subsequent operations. Remove protective items when no longer needed, prior to Substantial Completion of the Work.
- B. Control traffic to prevent damage to equipment, materials, and surfaces.
- C. Coverings:
 1. Provide temporary coverings to protect materials and equipment from damage.
 2. Cover projections, wall corners and jambs, sills, and soffits of openings, in areas used for traffic and for passage of materials and equipment in subsequent work.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 73 19

INSTALLATION

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. This Section describes general requirements for installing materials and equipment. Additional installation requirements are included in the various Specifications Sections in Divisions 02 through 49 and elsewhere in the Contract Documents.
 - 2. CONTRACTOR shall provide all labor, materials, equipment, services, tools, and incidentals required to install materials and equipment.

1.2 QUALITY ASSURANCE

- A. General:
 - 1. Provide appropriate quality assurance for installing materials and equipment, and provide quality control over Suppliers, materials and equipment, services, Site conditions, and workmanship, to provide Work of the required quality.
- B. Qualifications:
 - 1. Installer:
 - a. Installers shall be experienced in the types of Work required, including, but not limited to, the requirements of Section 01 42 00, References, and the Division 02 through 49 Specifications where the particular element of the Work is specified.
- C. Regulatory Requirements: Comply with the following:
 - 1. 29 CFR 1910, OSHA.

PART 2 – PRODUCTS

2.1 EQUIPMENT DRIVE GUARDS

- A. Equipment Drive Guards – General:
 - 1. Unless otherwise shown or indicated, provide all-metal guards complying with 29 CFR 1910, Subpart O, with equipment driven by open shafts, belts, chains, pulleys, sheaves, or gears. Guards shall enclose drive and driven mechanism.
 - 2. If material of guards are not otherwise specified, guards shall be galvanized sheet steel, galvanized woven wire, or expanded metal set in a frame of galvanized steel members, as appropriate.

3. Secure guards in position by steel braces or straps, securely fastened to frame of equipment, floor, or wall as required.
4. Fastenings shall allow removal of guards for servicing equipment.

2.2 MISCELLANEOUS MATERIALS

- A. Shims shall be Type 304L stainless steel, clean and free of slag.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Installation Instructions and Requirements:
 - a. Install materials and equipment in accordance with approved Shop Drawings and CONTRACTOR's other submittals approved by ENGINEER, the Contract Documents, and manufacturer's installation instructions. When manufacturer's installation instructions conflict with the Contract Documents, obtain interpretation or clarification from ENGINEER before proceeding.
 - b. Manufacturer's installation instructions include manufacturer's written instructions; drawings; illustrative, wiring and schematic diagrams; diagrams identifying external connections, terminal block numbers and internal wiring; and other such information pertaining to installation of materials and equipment. Included are all of manufacturer's printed installation instructions, including those that may be attached to equipment upon delivery.
2. Prior to installing materials and equipment, complete preparation of surfaces on which materials and equipment are to be installed. Prior to installing materials and equipment on new concrete, concrete shall achieve sufficient compressive strength to support the materials and equipment.
3. Maintain the work area in a broom-clean condition while installing materials and equipment.
4. Use proper tools to assemble materials and equipment. Do not deform or mar surface of shafts, nuts, and other parts.
5. Do not support rigging from building or structure without written permission of ENGINEER. CONTRACTOR is responsible for and shall repair damage to building or structure resulting from CONTRACTOR's operations, in accordance with Section 01 71 33, Protection of the Work and Property.
6. During installation, maintain materials and equipment in neutral position and do not exert undue stress on materials and equipment.
7. Tighten connections requiring gaskets evenly all around to ensure uniform stress over entire gasket.
8. Use only an oil bath heater to expand couplings, gears, and other mechanical components to be expanded for installation. Do not force or drive couplings,

gears, and other mechanical components onto equipment shafts, or subject such items to open flame or torch.

9. Do not alter or repair materials and equipment and do not burn or weld materials and equipment unless required in the Contract Documents or allowed by ENGINEER.
10. Provide plugs in lubrication holes to prevent entry of foreign matter.

B. Setting and Erection:

1. Install materials and equipment plumb, level, true, and free of rack unless otherwise shown or indicated, and demonstrate plumbness and level to ENGINEER. Bring parts to proper bearing after installation and erection.
2. Anchorages:
 - a. Provide anchorage setting drawings in time to coordinate with fabrication of materials and equipment and the Work.
 - b. Anchorages shall comply with Section 05 05 33, Anchor Systems. Requests for approval of substitute materials or methods of anchorage shall be in accordance with the General Conditions, Supplementary Conditions, and Section 01 25 00, Substitution Procedures.
3. Shimming:
 - a. Wedging is not allowed.
 - b. During installation, use the minimum number of shims required for leveling the equipment.
 - c. Provide shims, filling pieces, keys, packing, grouting of the type required by the Contract Documents, and other materials and equipment necessary to properly align, level, and secure apparatus in place.
4. Installing Equipment onto Foundations:
 - a. Using experienced millwrights, carefully set and align equipment on foundations, after equipment soleplates or baseplates (as applicable) have been shimmed to true alignment at anchorages.
 - b. Set anchorages in place and tighten nuts against shims.
 - c. Check bedplates or wing feet of equipment after securing to foundations and, after confirming alignments, grout soleplates or baseplates (as applicable) in place in accordance with the Contract Documents.
5. Ream misaligned holes. Do not "force" bolts or keys.
6. Where applicable, properly align equipment with associated piping and utility connections, without exerting undue stress on connecting piping and utilities.

C. Alignment and Leveling:

1. Verify that all shafts, couplings, and sheaves are properly aligned and adjust to required tolerances.
2. Align couplings while equipment is free of external loads.
3. Check angular and parallel alignment and record actual alignment and submit to ENGINEER. Alignment shall be within tolerances specified in Contract Documents and as recommended by Supplier of the material or equipment item.

4. Use laser indicators or dial indicators for checking angular and parallel alignment. Using dial indicators requires that, during rotation of half-couplings in performing testing, dial indicator shall be maintained in same relative position, and dial indicator readings taken at same place on circumference of coupling.
- D. Threaded Connections:
1. Apply a molybdenum disulfide, anti-seize compound to threads in mechanical connections such as bolts, studs, cap screws, tubing, and other threads, unless otherwise shown or indicated.

3.2 FIELD QUALITY CONTROL

- A. Supplier's Services:
1. When specified, provide competent, qualified representatives of material or equipment Supplier to perform services required, including: supervising installation, checking the completed installation, adjusting, testing of materials and equipment, and where required instructing operations and maintenance personnel in the use and care of materials and equipment.

+ + END OF SECTION + +

SECTION 01 73 24

CONNECTIONS TO EXISTING FACILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes requirements for connections to existing facilities. Requirements for tie-ins and shutdowns necessary to complete the Work are in Section 01 14 16, Coordination with Owner's Operations.
2. CONTRACTOR shall provide labor, materials, tools, equipment, and incidentals shown, specified, and required for performing connections to existing facilities.

B. Coordination:

1. Review installation procedures under other Sections and coordinate Work that will be performed with or before the Work specified in this Section.

C. Related Sections:

1. Section 01 14 16, Coordination with Owner's Operations.
2. Section 01 51 41, Temporary Pumping.
3. Section 01 73 29, Cutting and Patching.

D. General:

1. Requirements for shutdowns, tie-ins, and other provisions on connections to existing facilities, are indicated in Section 01 14 16, Coordination with Owner's Operations.
2. Requirements for temporary pumping for connections to existing facilities are in Section 01 14 16, Coordination with Owner's Operations, and Section 01 51 41, Temporary Pumping.
3. Requirements for cutting and patching are in Section 01 73 29, Cutting and Patching.
4. To extent possible, materials, equipment, systems, piping, and appurtenances that will be placed into service upon completion of connection to existing facilities shall be checked, successfully tested, and in condition for operation prior to making connections to existing facilities, if valves, gates, or similar watertight and gastight isolation devices are not provided at the connection point.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes general requirements for cutting and patching Work.
2. CONTRACTOR shall perform cutting and coring, and rough and finish patching of holes and openings in existing construction.
3. Provide cutting, coring, fitting and patching, including attendant excavation and fill, required to complete the Work, and to:
 - a. remove and replace defective Work;
 - b. remove samples of installed Work as specified or required for testing;
 - c. remove construction required to perform required alterations or additions to existing construction;
 - d. uncover the Work for ENGINEER's observation of covered Work, testing or inspection by testing entities, or observation by authorities having jurisdiction;
 - e. connect to completed Work not performed in proper sequence;
 - f. remove or relocate existing utilities and piping that obstruct the Work in locations where connections are to be made;
 - g. make connections or alterations to existing or new facilities.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:

1. Cutting and Patching Request:
 - a. Submit written request to ENGINEER, well in advance of executing cutting or alteration that affects one or more of the following:
 - 1) Design function or intent of Project.
 - 2) Work of OWNER.
 - 3) Structural value or integrity of an element of the Project.
 - 4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 5) Efficiency, operational life, maintenance, or safety of operational elements.
 - 6) Visual qualities of sight-exposed elements.
 - b. Request shall include:
 - 1) Identification of Project and Contract designation.
 - 2) Description of affected Work of CONTRACTOR and work of others (if any).
 - 3) Necessity for cutting.

- 4) Effect on work or operations of OWNER, other contractors (if any), and on structural or weatherproof integrity of Project.
 - 5) Description of proposed Work, describing: scope of cutting and patching; trades who will be executing the Work; materials and equipment to be used; extent of refinishing; schedule of operations; alternatives to cutting and patching, if any, and net effect on aesthetics following completion of finishing Work.
 - 7) Designation of entity responsible for cost of cutting and patching, when applicable.
 - 8) Written permission of other prime contractors (if any) whose work will or may be affected.
2. Recommendation Regarding Cutting and Patching:
 - a. Should conditions of work or schedule indicate a change of materials or methods, submit written recommendation to ENGINEER including:
 - 1) Conditions indicating change.
 - 2) Recommendations for alternative materials or methods.
 - 3) Items required with request for approval of substitute, in accordance with the substitution request requirements of the Contract Documents.
 3. Product Data:
 - a. Submit manufacturer's data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces.
 - b. When not required under other Sections, submit manufacturer's data on materials to be used for finishing around the cut or patched area.
 - c. Furnish submittals for patching materials under the associated Specifications Section.
- B. Informational Submittals: Submit the following:
1. Written Notification of Cutting and Patching:
 - a. Submit written indication designating the day and time that the construction associated with cutting and patching will be uncovered to allow for observation. Do not begin cutting or patching operations until submittal is accepted by ENGINEER.
 2. X-ray Investigations:
 - a. Proposed method of investigation. Submit and obtain ENGINEER's acceptance prior to performing X-ray inspections.
 - b. Report of X-ray evaluation of slabs, floors, and walls to be cut or core-drilled.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Materials - General:
1. Use materials that comply with the Contract Documents.

2. If not shown or indicated in the Contract Documents, use materials that are identical to existing materials affected by cutting and patching Work.
 3. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, use materials whose installed performance will equal or surpass that of existing materials.
 4. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using materials that do not void required or existing warranties.
- B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:
1. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with solvent-free, two-component, protective, epoxy resin coating.
 2. Color shall approximate the finish color of the existing surface to be coated.
 3. Product and Manufacturer: Provide one of the following:
 - a. Sikagard 62, by Sika Corporation.
 - b. Or equal.

PART 3 – EXECUTION

3.1 GENERAL

- A. Perform cutting and coring in such manner that limits extent of patching required.
- B. Structural Elements:
1. Do not cut or patch structural elements in manner that would change the element's structural load-carrying capacity as load deflection ratio.
- C. Operating Elements:
1. Do not cut or patch operating elements in manner that would reduce their capacity to perform as intended.
 2. Do not cut or patch operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.
- D. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using methods that do not void required or existing warranties.

3.2 INSPECTION

- A. Examine surfaces to be cut or patched, and conditions under which cutting or patching will be performed before starting cutting or patching Work.
- B. Report unsatisfactory or questionable conditions to ENGINEER in writing. Do not proceed with cutting or patching Work until unsatisfactory conditions are corrected.

C. Non-Destructive Investigation:

1. In advance of cutting or coring through existing slabs or walls, use X-ray or other non-destructive methods accepted by ENGINEER to determine location of reinforcing steel, electrical conduits, and other items embedded in slabs or walls.
2. Submit to ENGINEER written report of findings of evaluation.
3. Perform X-ray investigation and submit results to ENGINEER sufficiently in advance of cutting Work to allow time to identify and implement alternatives, if changes to the Work are necessary because of conduit or other features in floor or wall.

3.3 PREPARATION

- A. Provide temporary support required to maintain structural integrity of facilities, to protect adjacent work from damage during cutting, and to support the element(s) to be cut.
- B. Protection of Existing Construction during Cutting and Patching:
1. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project and facility that will be exposed during cutting and patching operations.
 2. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
 3. Do not cut existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.4 CORING

- A. Use core-drilling to make penetrations through concrete and masonry walls, slabs, or arches, unless otherwise accepted by ENGINEER in writing.
- B. Coring:
1. Perform coring with non-impact rotary tool using diamond core-drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required, to be installed through the penetration.
 2. Do not core-drill through electrical conduit or other utilities embedded in walls or slabs without approval of ENGINEER. To extent possible, avoid cutting reinforcing steel in slabs and walls.
- C. Protection:
1. Protect existing equipment, utilities, and adjacent areas from water and other damage caused by or resulting from core-drilling operations.
 2. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with protective coating material

indicated in Paragraph 2.1.B of this Section. Apply protective coating in accordance with manufacturer's instructions.

D. Cleaning:

1. After core-drilling, vacuum or otherwise remove slurry and tailings from the work area.

3.5 CUTTING

A. Cutting – General:

1. Cut existing construction using methods least-likely to damage elements retained and adjoining construction and that provide proper surfaces to receive subsequent installation or repair.
2. In general, use hand tools or small power tools suitable for sawing or grinding. When possible, avoid using hammering and avoid chopping.
3. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces.
4. Prior to starting cutting, provide adequate bracing of area to be cut.
5. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.
6. Provide equipment of adequate size to remove the cut panel or "coupon".
7. Provide temporary covering over cut openings where not in use.

B. Cutting – Concrete and Masonry:

1. Cut through concrete and masonry using concrete wall saw with diamond saw blades.
2. On both of the element being cut, provide for control of slurry generated during sawing.
3. After cutting concrete and before installing subsequent construction on or through the opening, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Section. Apply protective coating in accordance with manufacturer's instructions.

3.6 PATCHING

A. Patching – General:

1. Patch construction by filling, repairing, refinishing, closing-up, and similar operations following performance of other Work.
2. Patch with durable seams that are as inconspicuous as possible. Provide materials and comply with installation requirements indicated in the Contract Documents.
3. Patch to provide airtight and watertight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
4. Where feasible, test patched areas to demonstrate integrity of installation.

B. Restoration:

1. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in manner that eliminates evidence of patching and refinishing.
2. For continuous surfaces, refinish to nearest intersection.
3. For an assembly, refinish the entire unit that was patched.
4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 CLEANING

A. Cleaning and Restoration:

1. Clean areas and spaces where cutting, coring, or patching were performed.
2. Clean piping, conduit, and similar constructions before applying paint or other finishing materials.
3. Restore damaged coverings of pipe and other utilities to original condition.

+ + END OF SECTION + +

SECTION 01 74 05

CLEANING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes requirements for keeping the Site free of accumulations of waste materials during construction (“progress cleaning”) and cleaning for Substantial Completion and prior to final inspection (collectively, “closeout cleaning”).
2. CONTRACTOR shall perform cleaning during the Project, including progress cleaning, upon completion of the Work, and as required by the General Conditions, as may be modified by the Supplementary Conditions, and this Section.
3. Maintain in a clean manner the Site, the Work, and areas adjacent to or affected by the Work.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. NFPA 241, Safeguarding Construction, Alteration, and Demolition Operations.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PROGRESS CLEANING

A. General:

1. Clean the Site, work areas, and other areas occupied by CONTRACTOR not less than weekly. Dispose of materials in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and the following:
 - a. Comply with NFPA 241 for removing combustible waste materials and debris.
 - b. Do not hold non-combustible materials at the Site more than three days if the temperature is expected to rise above 80 degrees F. When temperature is less than 80 degrees F, dispose of non-combustible materials within seven days of their generation.
 - c. Provide suitable containers for storage of waste materials and debris.

- d. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.
- B. Site:
 - 1. Keep outdoor, dust-generating areas wetted down or otherwise control dust emissions.
 - 2. Not less than weekly, brush-sweep roadways and paved areas at the Site that are used by construction vehicles or otherwise affected by construction activities.
 - 3. Comply with dust control requirements of Section 01 57 05, Temporary Controls.
- C. Work Areas:
 - 1. Clean areas where the Work is in progress to maintain the extent of cleanliness necessary for proper execution of the Work.
 - 2. Remove liquid spills promptly. Immediately report spills to OWNER, ENGINEER, and authorities having jurisdiction, in accordance with the Contract Documents and Laws and Regulations.
 - 3. Where dust would impair proper execution of the Work, broom-clean or vacuum entire work area, as appropriate.
 - 4. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- D. Installed Work:
 - 1. Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of material or equipment installed, using only cleaning agents and methods specifically recommended by material or equipment manufacturer. If manufacturer does not recommend specific cleaning agents or methods, use cleaning agents and methods that are not hazardous to health and property and that will not damage exposed surfaces.
- E. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration until Substantial Completion.
- F. Cutting and Patching:
 - 1. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, trailings and cuttings, and similar materials.
 - 2. Thoroughly clean piping, conduits, and similar features before applying patching material, paint, or other finishing materials. Restore damaged coverings on piping, ducting, and similar items to its pre-construction condition.
- G. Waste Disposal:
 - 1. Properly dispose of waste materials, surplus materials, debris, and rubbish off the Site.
 - 2. Do not burn or bury rubbish and waste materials at the Site.

3. Do not discharge volatile or hazardous substances, such as mineral spirits, oil, or paint thinner, into storm sewers or sanitary sewers.
 4. Do not discharge wastes into surface waters or drainage routes.
 5. CONTRACTOR is solely responsible for complying with Laws and Regulations regarding storing, transporting, and disposing of waste generated by CONTRACTOR's operations or brought to the Site by CONTRACTOR.
- H. During handling and installation of materials and equipment, clean and protect construction in progress and adjoining materials and equipment already in place. Apply protective covering where required for protection from damage or deterioration, until Substantial Completion.
- I. Clean completed construction as frequently as necessary throughout the construction period.

3.2 CLOSEOUT CLEANING

- A. Complete the following prior to requesting inspection for Substantial Completion:
1. Clean and remove from the Site rubbish, waste material, debris, and other foreign substances.
 2. Sweep paved areas broom-clean. Remove petrochemical spills, stains, and other foreign deposits.
 3. Hose-clean sidewalks and loading areas.
 4. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 5. Leave surface waterways, drainage routes, storm sewers, and gutters open and clean.
 6. Repair pavement, roads, sod, and other areas affected by construction operations and restore to specified condition; if condition is not specified, restore to pre-construction condition.
 7. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign substances.
 8. Clean, wax, and polish wood, vinyl, and painted floors.
 9. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, and similar spaces.
 10. In unoccupied spaces, sweep concrete floors broom-clean.
 11. Clean transparent materials, including mirrors and glazing in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 12. Remove non-permanent tags and labels.
 13. Surface Finishes:
 - a. Touch-up and otherwise repair and restore chipped, scratched, dented or otherwise marred surfaces to specified finish and match adjacent surfaces.

- b. Do not paint over “UL” or similar labels, including mechanical and electrical nameplates.
- 14. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint, and mortar droppings, and other foreign substances.
- 15. Clean plumbing fixtures to sanitary condition, free of stains, including stains resulting from water exposure.
- 16. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- 17. Clean lighting fixtures, lamps, globes, and reflectors to function with full efficiency. Replace temporary lamps provided in permanent fixtures. Replace existing lighting fixture components that are burned out or noticeably dimmed from use during construction. Replace defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
- 18. Leave the Site clean, and in neat, orderly condition, satisfactory to OWNER and ENGINEER.

+ + END OF SECTION + +

SECTION 01 75 11

CHECKOUT AND STARTUP PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall initially start up and place equipment and systems installed under the Contract into successful operation, in accordance with the equipment manufacturer's written instructions and as instructed by Supplier at the Site.
2. Provide all material, labor, tools, and equipment required to complete equipment checkout and start-up.
3. Provide chemicals, lubricants, and other required operating fluids.
4. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.
5. General activities by CONTRACTOR include the following:
 - a. Cleaning, as required under other provisions of the Contract Documents.
 - b. Removing temporary protective coatings.
 - c. Flushing and replacing lubricants, where required by manufacturer.
 - d. Lubrication.
 - e. Checking shaft and coupling alignments and resetting where required.
 - f. Checking and setting motor, pump, and other equipment rotation, safety interlocks, and belt tensions.
 - g. Checking and correcting (as necessary) leveling plates, grout, bearing plates, anchorage devices, fasteners, and alignment of piping, conduits, and ducts that may place stress on the connected equipment.
 - h. Performing all adjustments required.

B. Coordination:

1. Coordinate checkout and start-up with other contractors, as necessary.
2. Do not start up system or subsystem for continuous operation until all components of that system or subsystem, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
3. OWNER will furnish sufficient personnel to assist CONTRACTOR in starting up equipment, but responsibility for proper operation is CONTRACTOR's.
4. Supplier shall be present during checkout, startup, and initial operation, unless otherwise acceptable to ENGINEER.
5. Startup of heating equipment, air conditioning equipment, and other equipment that provides cooling or other temperature control, and systems is dependent upon the time of year. Return to the Site at beginning of next heating or cooling season (as applicable) to recheck and start the appropriate systems.

6. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by CONTRACTOR in accordance with Section 01 78 23, Operations and Maintenance Data.
- C. OWNER's Assumption of Responsibility for Equipment and Systems:
1. OWNER will assume responsibility for the equipment upon Substantial Completion, unless otherwise mutually agreed upon by OWNER and CONTRACTOR or as documented in the certificate of Substantial Completion.
 2. Before turning over to OWNER responsibility for operating and maintaining system or equipment CONTRACTOR shall:
 - a. Provide training of operations and maintenance personnel in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - b. Complete performance of equipment and system field quality control testing in accordance with the Contract Documents, to the extent possible.
 - c. Submit acceptable final operations and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
 - d. Obtain from ENGINEER final certificate of Substantial Completion for either entire Work or the portion being turned over to OWNER.

1.2 SUBMITTALS

- A. Closeout Submittals: Submit the following:
1. Certifications:
 - a. Supplier's certification of installation in accordance with Paragraph 3.1.B of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SERVICES OF SUPPLIER

- A. When specified, furnish services of competent, qualified representatives of material and equipment manufacturers, including supervising installation, adjusting, checkout, startup, and testing of materials and equipment.
- B. Certification:
1. When services by Supplier are required at the Site, within 14 days after first test operation of equipment, submit to ENGINEER a letter from Supplier, on Supplier's letterhead, stating that materials and equipment are installed in accordance with Supplier's requirements and installation instructions, and in accordance with the Contract Documents.
 2. In lieu of Supplier letter, submit completed form attached to this Section.

3. Include in the final operations and maintenance manual for the associated equipment a copy of the letter or completed form, as applicable.

3.2 MINIMUM STARTUP REQUIREMENTS

- A. Bearings and Shafting:
 1. Inspect for cleanliness, and clean and remove foreign matter.
 2. Verify alignment.
 3. Replace defective bearings and those that operate in a rough or noisy manner.
 4. Grease as necessary, in accordance with manufacturer's recommendations.
- B. Drives:
 1. Adjust tension in V-belt drives and adjust vari-pitch sheaves and drives for proper equipment speed.
 2. Adjust drives for alignment of sheaves and V-belts.
 3. Clean and remove foreign matter before starting operation.
- C. Motors:
 1. Check each motor for comparison to amperage nameplate value.
 2. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.
- D. Pumps:
 1. Check glands and seals for cleanliness and adjustment before running pump.
 2. Inspect shaft sleeves for scoring.
 3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
 4. Verify that piping system is free of dirt and scale before circulating liquid through pump.
- E. Valves:
 1. Inspect manual and automatic control valves, and clean bonnets and stems.
 2. Tighten packing glands to ensure no leakage, but allow valve stems to operate without galling.
 3. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
 4. Replace packing on valves that continue to leak.
 5. Remove, correct, and replace bonnets that leak.
 6. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".
- F. Verify that control valve seats are free of foreign matter and are properly positioned for intended service.
- G. Pipe Joints and Other Connections:
 1. Tighten flanges and other pipe joints after system has been placed in operation.
 2. Replace gaskets that show signs of leakage after tightening.
 3. Inspect all joints for leakage.

4. Promptly remake each joint that appears to be faulty; do not wait for rust or other corrosion to form.
 5. Clean threads on both parts, and apply compound and remake joints.
- H. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.
- I. Open steam traps and air vents, where used, and remove operating elements. Clean thoroughly, replace internal parts, and place back into operation.
- J. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.
- K. Set and calibrate draft gauges of air filters and other equipment.
- L. Inspect fan wheels for clearance and balance. Provide factory-authorized personnel for adjustment where needed.
- M. Check each electrical control circuit to verify that operation complies with the Contract Documents.
- N. Inspect each pressure gauge, thermometer, and other instruments for calibration. Replace items that are defaced, broken, or that read incorrectly.
- O. Repair damaged insulation.
- P. Excess Gasses and Fluids:
1. Vent gasses trapped in systems.
 2. Verify that liquids are drained from all parts of gas or air systems.

3.3 ATTACHMENTS

- A. The attachment listed below, following this Section's "End of Section" designation, is a part of this Specification Section.
1. Supplier's Installation Certification Form (one page).

+ + END OF SECTION + +

SUPPLIER'S INSTALLATION CERTIFICATION

Contract No. and Name: _____

Equipment Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturer of Equipment: _____

The undersigned Supplier of the equipment or system described above hereby certifies that Supplier has checked the installation of the equipment or system and that the equipment or system, as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations and the Contract Documents, and that the trial operation of the equipment or system has been satisfactory.

Comments: _____

Date

Supplier Name (print)

Signature of Supplier

Date

Contractor Name (print)

Signature of Contractor

++ NO TEXT ON THIS PAGE ++

SECTION 01 78 23

OPERATIONS AND MAINTENANCE DATA

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes requirements for manufacturers' operations and maintenance manuals and related data to be furnished by CONTRACTOR.
2. CONTRACTOR shall submit operation and maintenance data, in accordance with this Section and in accordance with requirements elsewhere in the Contract Documents, as instructional and reference manuals by operations and maintenance personnel at the Site.
3. Required operation and maintenance data groupings are listed in table(s) in Article 1.2 of this Section. At minimum, submit operation and maintenance data for:
 - a. All equipment and systems.
 - b. Valves, gates, actuators, and related accessories.
 - c. Instrumentation and control devices.
 - d. Electrical equipment.
4. For each operation and maintenance manual, submit the following:
 - a. Preliminary Submittal: Printed and bound copy of entire operation and maintenance manual, except for test data, service reports by Supplier, and submit electronic copies.
 - b. Final Submittal: Printed and bound copy of complete operations and maintenance manual, including test data and service reports by Supplier, and submit electronic copies.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
 - a. Submit the operations and maintenance data indicated in the Contract Documents, grouped into submittals as indicated in Table 01 78 23-A:

TABLE 01 78 23-A, REQUIRED OPERATIONS AND MAINTENANCE DATA

Name of O&M Manual/Data	For Materials or Equipment Specified in Section(s)
Hollow Metal Doors and Frames	08 11 13
Plumbing Fixtures	22 40 00
HVAC Equipment	Division 23
Electrical Equipment	Division 26
Process Valves	Division 40

Name of O&M Manual/Data	For Materials or Equipment Specified in Section(s)
Instrumentation & Control	40 60 05
Hoists	41 22 23
Submersible End Suction Pumps	43 21 39.13
Aluminum Slide Gates	43 26 21
Odor Control Systems	44 31 19
Inline Grinders	46 34 33

B. Quantity Required and Timing of Submittals:

1. Preliminary Submittal:
 - a. Printed Copies: Two copies, exclusive of copies required by CONTRACTOR.
 - b. Electronic Copies: In accordance with Section 01 31 26, Electronic Communication Protocols.
 - c. Submit to ENGINEER by the earlier of: 90 days following approval of Shop Drawings and product data submittals, or 10 days prior to starting training of operations and maintenance personnel, or 10 days prior to field quality control testing at the Site.
2. Final Submittal: Furnish final submittal prior to Substantial Completion, unless submittal is specified as required prior to an interim Milestone.
 - a. Printed Copies: Three copies.
 - b. Electronic Copies: In accordance with Section 01 31 26, Electronic Communication Protocols.

1.3 FORMAT OF PRINTED COPIES

A. Binding and Cover:

1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be not less than one inch wide and maximum of three inches wide. Binders for each copy of each volume shall be identical.
2. Binders shall be locking three-ring/"D"-ring type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front of each volume.
3. Do not overfill binders.
4. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.
5. Provide the following information on cover of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - d. Name of Project and, if applicable, Contract name and number.
 - e. Name of building or structure, as applicable.
6. Provide the following information on spine of each volume:

- a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
- b. Name or type of material or equipment covered in the manual.
- c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
- d. Project name and building or structure name.

B. Pages:

1. Print pages in operations and maintenance manual on 30-pound (minimum) paper, 8.5 inches by 11 inches in size.
2. Reinforce binding holes in each individual sheet with plastic, cloth, or metal. When published, separately-bound booklets or pamphlets are part of the manual, reinforcing of pages within booklet or pamphlet is not required.
3. Furnish each page with binding margin not less than one inch wide. Punch each page with holes suitable for the associated binding.

C. Drawings:

1. Bind into the operation and maintenance manual drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing specified for pages.
2. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Include not more than three drawing sheets per pocket.

D. Copy Quality and Document Clarity:

1. Contents shall be original-quality copies. Documents in the operations and maintenance manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals that contain copies that are unclear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable. Faxed copies are unacceptable.
2. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content. Using highlighters to so indicate options furnished is unacceptable.

E. Organization:

1. Table of Contents:
 - a. Provide table of contents in each volume of each operations and maintenance manual.
 - b. In table of contents and not less than once in each chapter or section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using

material or equipment model or catalog designations for identification is unacceptable.

2. Use dividers and indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

1.4 FORMAT OF ELECTRONIC COPIES

A. Electronic Copies of Operation and Maintenance Manuals:

1. Each electronic copy shall include all information included in the corresponding printed copy.
2. Submit electronic copies in accordance with Section 01 31 26, Electronic Communications Protocols.
3. File Format:
 - a. Files shall be in “portable document format” (PDF). Files shall be electronically searchable.
 - b. Submit separate file for each separate document in the printed copy.
 - c. Within each file, provide bookmarks for the following:
 - 1) Each chapter and subsection listed in the corresponding printed copy document’s table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix.

B. Copies of Programming and Configuration Files:

1. Furnish on CD or portable USB “thumb drive” copy of all software programming, such as programmable logic controller programs, prepared specifically for the Project. Third-party, licensed, commercially available software is excluded from requirements of this Article; submit copies of commercially-available, licensed, third-party software, where required, in accordance with the Contract Documents.
2. Submit on CD or portable USB “thumb drive” copies of system configuration prepared specifically for the Project, such as plant monitoring system and SCADA display configurations.
3. Submit programming and configuration files concurrently with electronic copies of operation and maintenance data.

1.5 CONTENT

A. General:

1. Prepare each operations and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-built drawings as applicable, bills of materials, technical bulletins, installation and handling requirements, maintenance and repair instructions, and other information required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for

the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.

2. Completeness and Accuracy:
 - a. Operation and maintenance manuals that include language stating or implying that the manual's content may be insufficient or stating that the manual's content is not guaranteed to be complete and accurate are unacceptable.
 - b. Operations and maintenance manuals shall be complete and accurate.
 - c. Operation and maintenance manuals shall indicate the specific alternatives and features furnished, and the specific operation and maintenance provisions for the material or equipment furnished.
 3. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
- B. Submit written explanations of safety considerations relating to operation and maintenance procedures.
- C. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
1. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
 2. Recommended schedule for each preventive maintenance task.
 3. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
 4. Table of alternative lubricants.
 5. Troubleshooting instructions.
 6. List of required maintenance tools and equipment.
- D. Submit complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
1. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 2. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.

3. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
4. For each part or piece include the following information:
 - a. Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
 - b. Part name or description.
 - c. Manufacturer's part number.
 - d. Quantity of each part used in each assembly.
 - e. Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.
- E. Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.
- F. Submit manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
- G. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment. Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.
- H. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
- I. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
- J. Programmable Logic Controllers: If programmable logic controllers are furnished under the Contract:
 1. Submit complete logic listings.
 2. Submit complete programmable logic controller listing of all input/output

address assignments, tag assignments, and pre-set constant values, with functional point descriptions.

3. Submit complete manufacturer's programming manuals.
- K. Submit copy of warranty bond and service contract as applicable.
- L. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. This Section includes requirements for Project record documents, to supplement the requirements of the General Conditions, as may be modified by the Supplementary Conditions.
2. CONTRACTOR shall provide all labor, materials, equipment, and services to maintain and submit to ENGINEER Project record documents in accordance with the Contract Documents.

B. Maintenance of Record Documents:

1. Maintain in CONTRACTOR's field office, in clean, dry, legible condition, complete sets of the following record documents: Drawings, Specifications, and Addenda; Shop Drawings, Samples, and other CONTRACTOR submittals, including records of test results, approved or accepted as applicable, by ENGINEER; Change Orders, Work Change Directives, Field Orders, copies of all interpretations and clarifications issued, photographic documentation, survey data, and all other documents pertinent to the Work.
2. Provide files and racks for proper storage and easy access to record documents. File record documents in accordance with the edition of the Construction Specification Institute's *MasterFormat*TM used for organizing the Project Manual, unless otherwise accepted by ENGINEER.
3. Promptly make record documents available for observation and review upon request of ENGINEER or OWNER. Requirements for review of record documents status as a condition precedent to progress payments is in Section 01 29 73, Schedule of Values, and Section 01 29 76, Progress Payment Procedures.
4. Do not use record documents for any purpose other than serving as Project record. Do not remove record documents from CONTRACTOR's field office without ENGINEER's approval.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:

1. Record Documents:
 - a. Submit the following Project record documents:
 - 1) Drawings.
 - 2) Project Manual including Specifications and Addenda (bound).

- b. Prior to readiness for final payment, submit to ENGINEER one copy of Project's final record documents and obtain ENGINEER's acceptance of same. Submit complete record documents; do not make partial submittals.
 - c. Submit both printed record documents and electronic record documents, in accordance with Section 01 31 26, Electronic Communication Protocols.
 - d. Submit record documents with transmittal letter on CONTRACTOR letterhead in accordance with requirements in Section 01 33 00, Submittal Procedures.
2. Certifications:
- a. Record documents submittal shall include certification, with original signature of official authorized to execute legal agreements on behalf of CONTRACTOR, reading as follows:

"[Insert Contractor's corporate name] has maintained and submitted Project record documentation in accordance with the General Conditions and Supplementary Conditions, Section 01 78 39, Project Record Documents, and other elements of Contract Documents, for the Town of Trumbull, Beardsley Pump Station Comprehensive Upgrade. We certify that each record document submitted is complete, accurate, and legible relative to the Work performed under our Contract, and that the record documents comply with the requirements of the Contract Documents.

[Provide signature, print name, print signing party's corporate title, and date]"

1.3 RECORDING CHANGES

A. Recording Changes – General:

- 1. At the start of the Project, label each record document to be submitted as, "PROJECT RECORD" using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.
- 2. Keep record documents current consistent with the progress of the Work. Make entries on record documents within two working days of receipt of information required to record the change.
- 3. Do not permanently conceal the Work until required information has been recorded for Project record documents.
- 4. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from ENGINEER-accepted record documents.
- 5. Marking of Entries:
 - a. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to record documents.
 - b. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be

legible and sufficiently dark to allow scanning of record documents into legible electronic files in portable document format (“.PDF”).

- c. Date each entry on record documents.
- d. Indicate changes by drawing a “cloud” around the change(s) indicated.
- e. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

B. Drawings:

- 1. Record changes on copy of the Drawings. Submittal of CONTRACTOR-originated or -produced drawings as a substitute for recording changes on a copy of the Drawings is unacceptable.
- 2. Record changes on plans, sections, elevations, schematics, schedules, and details as required for clarity, making reference dimensions and elevations (to Project datum) for complete record documentation.
- 3. Record actual construction including:
 - a. Depths of various elements of foundation relative to Project datum.
 - b. Horizontal and vertical location of Underground Facilities referenced to permanent surface improvements and project elevation datum. For each Underground Facility, including pipe fittings, show and indicate dimensions to not less than two permanent, visible surface improvements.
 - c. Location of exposed utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure and, where applicable, to Project elevation datum.
 - d. Changes in structural and architectural elements of the Work, including changes in reinforcing.
 - e. Field changes of dimensions, arrangements, and details.
 - f. Changes made in accordance with Addenda, Change Orders, Work Change Directives, and Field Orders.
 - g. Changes in details on the Drawings. Submit additional details prepared by CONTRACTOR when required to document such changes.
- 4. Recording Changes for Schematic Layouts:
 - a. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by CONTRACTOR subject to acceptance by ENGINEER.
 - b. Record on the Project record documents all revisions to schematics on the Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Drawings. Show and indicate actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.
 - c. When dimensioned plans and dimensioned sections or elevations on the Drawings show the Work schematically, indicate on the record documents, by dimensions accurate to within one inch in the field,

centerline location of items of Work such as conduit, piping, ducts, and similar items

- 1) Clearly identify each item of the Work by accurate notations such as “cast iron drain”, “rigid electrical conduit”, “copper waterline”, and similar descriptions.
 - 2) Show by symbol or by note the vertical location of each item of the Work; for example, “embedded in slab”, “under slab”, “in ceiling plenum”, “exposed”, and similar designations. For piping not embedded, also indicate elevation dimension relative to Project elevation datum.
 - 3) Descriptions shall be sufficiently detailed to be related to the Specifications.
- d. ENGINEER may furnish written waiver of requirements relative to schematic layouts shown on plans, sections, and elevations when, in ENGINEER’s judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on such waiver(s) being issued.
5. Supplemental Drawings:
- a. In some cases, drawings produced during construction by ENGINEER or CONTRACTOR supplement the Drawings and shall be included with Project record documents submitted by CONTRACTOR. Supplemental record drawings shall include drawings or sketches that are part of Change Orders, Work Change Directives, and Field Orders and that cannot be incorporated into the Drawings because of space limitations.
 - b. Supplemental drawings submitted with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.
 - c. When supplemental drawings developed by CONTRACTOR using computer-aided drafting/design (CADD) software are to be included in record drawings, submit electronic files for such drawings in accordance with Section 01 31 26, Electronic Communication Protocols, as part of record drawing submittal. Label such files, “Supplemental Record Drawings”, including with CONTRACTOR’s name, Project name, and Contract designation.

C. Specifications and Addenda:

1. Mark each Specifications Section to record:
 - a. Manufacturer, trade name, catalog number, and Supplier of each material and equipment item actually provided.
 - b. Changes made by Addendum, Change Orders, Work Change Directives, and Field Orders.

1.4 ELECTRONIC FILES FURNISHED BY ENGINEER

- A. CADD files of the Drawings will be furnished by ENGINEER upon the following conditions:
1. CONTRACTOR shall submit to ENGINEER a letter on CONTRACTOR letterhead requesting CADD files of the Drawings and indicating specific definition(s) or description(s) of how such files will be used, and specific description of benefits to OWNER (including credit proposal, if applicable) if the request is granted.
 2. CONTRACTOR shall execute ENGINEER's standard agreement for release of electronic files and shall abide by the provisions of such agreement for release of electronic files.
 3. Layering system incorporated in CADD files shall be maintained as transmitted by ENGINEER. CADD files transmitted by ENGINEER containing cross-referenced files shall not be bound by CONTRACTOR. Drawing cross-references and paths shall be maintained. If CONTRACTOR alters layers or cross-reference files, CONTRACTOR shall restore all layers and cross-references prior to submitting record documents to ENGINEER.
 4. CONTRACTOR shall submit record drawings to ENGINEER in same CADD format that files were furnished to CONTRACTOR.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 01 78 43

SPARE PARTS AND EXTRA MATERIALS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
1. This Section includes administrative and procedural requirements for furnishing spare parts, extra materials, maintenance supplies, and special tools required for maintenance (collectively, “spare parts and extra materials”) required by the Contract Documents.
 2. CONTRACTOR shall furnish spare parts, extra materials, and associated information, for materials and equipment furnished in accordance with the Contract Documents. Furnish such items in accordance with the requirements of this Section and the Specifications sections in which such items are indicated.
 3. CONTRACTOR shall be fully responsible for loss and damage to spare parts and extra materials until such items are received by OWNER’s facility manager.
 4. Promptly replace spare parts and extra materials furnished by OWNER to CONTRACTOR for use in remedying defective Work.
- B. List of Spare Parts and Extra Materials:
1. With the Shop Drawings and product data submittals for each Specifications section, submit a complete listing of spare parts and extra materials required for maintenance for two years of operation, together with unit prices in current United States funds, and source(s) of supply for each.
 2. Also include listing of spare parts and extra materials, with pricing and sources, in the operations and maintenance data submitted in accordance with Section 01 78 23, Operations and Maintenance Data.

1.2 SUBMITTALS

- A. Maintenance Material Submittals: Submit the following:
1. Spare Parts and Extra Materials:
 - a. Furnish to OWNER in accordance with requirements of this Section, and the Specifications section in which the spare parts and extra materials are specified.
 2. Transfer Documentation: For each delivery of spare parts and extra materials, submit to ENGINEER the following:
 - a. Submit, on CONTRACTOR’s letterhead, a letter of transmittal for spare parts and extra materials furnished under each Specifications section. Letter of transmittal shall accompany spare parts and extra materials. Do

not furnish letter of transmittal separate from associated spare parts and extra materials.

- b. Furnish three original, identical, signed letters of transmittal for each delivery of spare parts and extra materials furnished under each Specifications section. Upon delivery of specified quantities and types of spare parts and extra materials to OWNER, designated person from OWNER will countersign each original letter of transmittal indicating OWNER's receipt of spare parts and extra materials in the quantity, type, and quality required by the Contract Documents. OWNER will retain one fully-signed original, CONTRACTOR shall submit one fully-signed original to ENGINEER. CONTRACTOR shall retain one fully-signed original for CONTRACTOR's records.
- c. Letter of transmittal shall include the following:
 - 1) Information required for letters of transmittal in Section 01 33 00, Submittal Procedures.
 - 2) Transmittal shall list spare parts and extra materials furnished under each Specifications Section. List each individual part, material, equipment item, tool, and product and the associated quantity furnished.
 - 3) Include space for countersignature by OWNER as follows: space for signature, space for printed name, and date.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Packaging and Labeling of Spare Parts and Extra Materials:
 - 1. Furnish spare parts and extra materials in manufacturer's unopened cartons, boxes, crates, or other original, protective covering suitable for preventing corrosion and deterioration for maximum length of storage normally anticipated by manufacturer.
 - 2. Packaging of spare parts and extra materials shall be clearly marked and identified with name of manufacturer, applicable material or equipment, part number, part description, and part location in the equipment or system.
 - 3. Protect and package spare parts and extra materials for maximum shelf life normally anticipated by manufacturer.
- B. Storage Prior to Delivery to Owner:
 - 1. Prior to furnishing spare parts and extra materials to OWNER, store spare parts and extra materials in accordance with the Contract Documents and manufacturers' recommendations.
- C. Procedure for Delivery to Owner:
 - 1. Deliver spare parts and extra materials to OWNER's permanent storage rooms at the Site or area(s) at the Site designated by OWNER.
 - 2. When spare parts and extra materials are delivered, CONTRACTOR and OWNER will mutually inventory the spare parts and extra materials delivered

to verify compliance with the Contract Documents regarding quantity, part numbers, and quality.

3. Additional procedures for delivering spare parts and extra materials to OWNER, if required, will be developed by ENGINEER and complied with by CONTRACTOR.
4. CONTRACTOR shall reimburse OWNER for all costs and expenses incurred by OWNER, including professional services, for delivery of inadequate, incorrect, or defective spare parts and extra materials. OWNER may withhold such amounts from payments due CONTRACTOR via set-offs in accordance with the Contract Documents.

D. Delivery Time and Eligibility for Payment:

1. Deliver to OWNER spare parts and extra materials prior to date of Substantial Completion for materials and equipment associated therewith.
2. Do not deliver spare parts and extra materials before commencing startup for associated material or equipment.
2. Spare parts and extra materials are not eligible for payment until delivered to OWNER and CONTRACTOR's receipt of OWNER's countersignature on letter of transmittal.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 01 79 23

INSTRUCTION OF OPERATIONS AND MAINTENANCE PERSONNEL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall furnish services of Supplier's operation and maintenance training specialists to instruct OWNER's and facility manager's personnel in recommended operating and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
2. Supplier shall provide a combination of classroom and field training at the Site, unless otherwise required elsewhere in the Contract Documents.
3. OWNER or facility manager reserves the right to record training sessions on video for OWNER's later use in instructing OWNER's or facility manager's personnel.

B. Scheduling of Training Sessions:

1. General:
 - a. CONTRACTOR shall coordinate training services with start-up and initial operation of materials and equipment on days and times, and in manner, acceptable to OWNER, in accordance with the Contract Documents.
 - b. Training may be required outside of normal business hours to accommodate schedules of operations and maintenance personnel. Furnish training services at the required days and times at no additional cost to OWNER.
2. Prerequisites to Training:
 - a. Training of facility operations and maintenance personnel shall commence after preliminary operation and maintenance data has been submitted and accepted by ENGINEER, and Work required in Section 01 75 11, Checkout and Startup Procedures is complete.
 - b. At option of OWNER or ENGINEER, training may be allowed to take place before, during, or after equipment startup.
3. Training Schedule Submittal:
 - a. Training Schedule Required: CONTRACTOR shall prepare and submit proposed training schedule for review and acceptance by ENGINEER and OWNER. Proposed training schedule shall show and indicate all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training for various elements of the Work, number of training sessions, and scheduling.

- b. Timing of Training Schedule Submittal: Submit initial training schedule not less than 60 days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with ENGINEER's comments, not later than 30 days prior to starting the first training session.
- c. OWNER reserved the right to modify personnel availability for training in accordance with process or emergency needs at the facility.

1.2 QUALITY ASSURANCE

A. Qualifications:

- 1. Manufacturer's Instructors:
 - a. Shall be factory-trained by manufacturer of material or equipment.
 - b. Manufacturer's instructors shall be proficient and experienced in performing training of the type required.
 - c. Instructors shall be proficient in spoken and written English language.
 - d. Qualifications of instructors are subject to acceptance by ENGINEER. If ENGINEER does not accept qualifications of proposed instructor, furnish services of replacement instructor with acceptable qualifications.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule submittals in accordance with time frames specified in this Section.

B. Informational Submittals: Submit the following:

- 1. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with Table 01 79 23-A and the Contract Documents. Lesson plan shall comply with requirements of this Section as may be supplemented by Specifications Sections where materials and equipment are specified. Include with lesson plan copy of handouts that will be used during training sessions. Furnish lesson plan submittals in accordance with time frames specified in this Section.
- 2. Qualifications:
 - a. Credentials of manufacturer's proposed operations and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.

C. Closeout Submittals: Submit the following:

1. Trainee sign-in sheets for each training session. Submit to OWNER's training coordinator with copy to ENGINEER.

1.4 LESSON PLAN

- A. Supplier's lesson plan shall describe specific instruction topics, system components for which training will be furnished, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.
- B. Submit acceptable lesson plan not less than 14 days prior to starting associated training.
- C. Indicate in lesson plan estimated duration of each training segment.
- D. Lesson plan shall include the following:
 1. Material and Equipment Overview (required for all types of operations and maintenance training):
 - a. Describe material and equipment's operating (process) function and performance objectives.
 - b. Describe material and equipment's fundamental operating principles and dynamics.
 - c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
 - d. Identify all support materials and equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
 - e. Identify and describe safety precautions and potential hazards related to operation.
 - f. Identify and describe in detail safety and control interlocks.
 2. Operations Personnel Training:
 - a. Material and Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
 - b. Operation:
 - 1) Describe operating principles and practices.
 - 2) Describe routine operating, startup, and shutdown procedures.
 - 3) Describe abnormal or emergency startup, operating, and shutdown procedures that may apply.
 - 4) Describe alarm conditions and responses to alarms.
 - 5) Describe routine monitoring and recordkeeping procedures.
 - 6) Describe recommended housekeeping procedures.
 - c. Troubleshooting:
 - 1) Describe how to determine if corrective maintenance or an operating parameter adjustment is required.
 3. Mechanical Maintenance Training:

- a. Material and Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
 - b. Material and Equipment Preventive Maintenance:
 - 1) Describe preventative maintenance inspection procedures required to:
 - a) Inspect materials and equipment in operation.
 - b) Identify potential trouble symptoms and anticipate breakdowns.
 - c) Forecast maintenance requirements (predictive maintenance).
 - 2) Define recommended preventative maintenance intervals for each component.
 - 3) Describe lubricant and replacement part recommendations and limitations.
 - 4) Describe appropriate cleaning practices and recommend intervals.
 - 5) Identify and describe use of special tools required for maintenance of materials and equipment.
 - 6) Describe component removal, installation, and disassembly and assembly procedures.
 - 7) Perform “hands-on” demonstrations of preventive maintenance procedures.
 - 8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
 - 9) Define recommended torquing, mounting, calibrating, and aligning procedures and settings, as appropriate.
 - 10) Describe recommended procedures to check and test equipment following corrective maintenance.
 - c. Equipment Troubleshooting:
 - 1) Define recommended systematic troubleshooting procedures.
 - 2) Provide component-specific troubleshooting checklists.
 - 3) Describe applicable materials and equipment testing and diagnostic procedures to facilitate troubleshooting.
 - 4) Describe common corrective maintenance procedures with “hands-on” demonstrations.
4. Instrumentation/Controls and Electrical Maintenance Training:
- a. Materials nad Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
 - b. Preventative Maintenance and Troubleshooting of Instrumentation and Control Systems.
 - c. Preventative Maintenance and Troubleshooting of Other Electrical Systems: In accordance with requirements for Paragraph 1.4.D.3 of this Section.

1.5 TRAINING AIDS

- A. Manufacturer’s instructor shall incorporate training aids as appropriate to assist in the instruction. Furnish handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:

1. Audio-visual aids, such as videos, Microsoft PowerPoint presentations, overhead transparencies, posters, drawings, diagrams, catalog sheets, or other items.
 2. Equipment cutaways and samples, such as spare parts and damaged equipment.
 3. Tools, such as repair tools, customized tools, and measuring and calibrating instruments.
- B. Handouts:
1. Manufacturer's instructor shall distribute and use descriptive handouts during training. Customized handouts developed especially for training for the Project are encouraged.
 2. Photocopied handouts shall be good quality and completely legible.
 3. Handouts should be coordinated with the instruction, with frequent references made to the handouts.
 4. Provide not less than 5 copies of each handout for each training session.
- C. Audio-visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. If suitable equipment is available at the Site, OWNER may make available OWNER's audio-visual equipment; however, do not count on OWNER providing audio-visual equipment. Audio-visual equipment that training provider shall provide, as required, includes:
1. Laptop computer, presentation software, extension cords and suitable projector.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 TRAINING DELIVERY

- A. Training Delivery – General:
1. Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear, and proceed according to lesson plan accepted by ENGINEER, with lesson content appropriate for trainees. If OWNER or ENGINEER deems that training delivery does not to comply with the Contract Documents, training shall be postponed, rescheduled, and re-performed in acceptable manner at no additional cost to OWNER.
 2. Trainee Sign-in Sheets: In format acceptable to OWNER, furnish sign-in sheet for trainees for each session. Sign-in sheets shall include the Project name, equipment or system for which training was furnished, and type of training (e.g., operations, mechanical maintenance, instrumentation/controls maintenance, or other), and name of each trainee. Upon completion of training, submit copy of each sign-in sheet as indicated in Article 1.3 of this Section.

B. "Hands-on" Demonstrations:

1. Manufacturer's instructor shall present "hands-on" demonstrations of operations and maintenance of materials and equipment for each training session, in accordance with lesson plan accepted by ENGINEER.
2. CONTRACTOR and manufacturer shall furnish tools necessary for demonstrations.

3.2 TRAINING SCHEDULE

- A. Manufacturer shall furnish not less than the hours of training and number of sessions indicated in Table 01 79 23-A of this Section. Travel time and expenses are responsibility of manufacturer and are excluded from required training time indicated in the Contract Documents.

TABLE 01 79 23-A, TRAINING SUMMARY TABLE

Material or Equipment	Specification Section	Total Training Time (hours)
HVAC Equipment	Division 23	4
Electrical Equipment	Division 26	8
Process Valves	Division 40	4
Instrumentation & Control	40 60 05	8
Hoists	41 22 23	4
Submersible End Suction Pumps	43 21 39.13	8
Aluminum Slide Gates	43 26 21	4
Odor Control Systems	44 31 19	8
Inline Grinders	46 34 33	8
Total		56

+ + END OF SECTION + +

SECTION 02 41 00

DEMOLITION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required for demolition, removal, and disposal Work.
2. The Work under this Section includes, but is not necessarily limited to:
 - a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of structural concrete, foundations, walls, doors, windows, structural steel, metals, masonry, attachments, appurtenances, piping, electrical and mechanical systems and equipment, paving, curbs, sidewalks, gutters, fencing and similar existing facilities.
 - b. Demolition and removal of all Underground Facilities underneath, and above-grade piping and utilities in, the building(s) and structures shown or indicated for demolition, unless the Underground Facilities or above-grade facilities are shown or indicated as to remain.
 - c. Remove from slabs, foundations, walls, and footings that are to be demolished all utilities and appurtenances embedded in such construction.
3. Demolitions and removals specified under other Sections shall comply with requirements of this Section.
4. Perform demolition Work within areas shown or indicated.
5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition.

B. Coordination:

1. Comply with Section 01 14 16, Coordination with Owner's Operations.
2. Review procedures under this and other Sections and coordinate the Work that will be performed with or before demolition and removals.

C. Related Sections:

1. Section 02 82 32, Asbestos Abatement.
2. Section 02 82 33, Lead-Based Paint Abatement.
3. Section 02 83 19, Non-Liquid PCB Material Removal.
3. Section 31 21 00, Rock and Boulder Excavation.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician legally qualified to perform electrical construction and electrical work in the jurisdiction where the Site is located.
 2. Plumbing Removals: Entity and personnel performing plumbing removals shall be plumber legally qualified to perform plumbing construction and plumbing work in the jurisdiction where the Site is located.
- B. Regulatory Requirements:
1. Demolition, removal, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T - Demolition), and all other Laws and Regulations.
 2. Comply with requirements of authorities having jurisdiction.

1.3 SUBMITTALS

- A. Informational Submittals: Submit the following:
1. Procedure Submittals:
 - a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
 - 1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
 - 2) Other proposed procedures as applicable.
 - 3) Equipment proposed for use in demolition operations.
 - 4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.
 - 5) Planned demolition operating sequences.
 - 6) Detailed schedule of demolition Work in accordance with the accepted Process Schedule.
 2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Section.
 3. Qualifications Statements:
 - a. Name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.
 - b. Name and qualifications of entity performing plumbing removals, including copy of licenses required by authorities having jurisdiction.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

- A. Notification:
 - 1. At least 48 hours prior to commencing demolition or removal, notify ENGINEER in writing of planned start of demolition Work. Do not start removals without permission of ENGINEER.
- B. Protection of Surrounding Areas and Facilities:
 - 1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and free and safe access to and from, structures and properties.
 - 2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.
 - 3. Provide temporary barriers, lighting, sidewalk sheds, and other necessary protection.
 - 4. Repair damage to facilities that are to remain.
- C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, do the following:
 - 1. Should uncharted or incorrectly charted Underground Facilities be encountered, CONTRACTOR responsibilities shall be in accordance with the General Conditions as may be modified by the Supplementary Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.
 - 2. Sanitary Sewer: Before proceeding with demolition, locate and cap all sewer lines and service laterals discharging from the building or structure being demolished.
 - 3. Storm Water: Existing storm water system shall remain in place until demolitions of existing building or structure is completed. Upon completing demolition, cut and cap storm sewer laterals at locations shown on the Drawings. Remove existing storm water piping and related structures between points of cutting, and backfill, restore to grade, and stabilize the area over the removed facilities.
 - 4. Water Piping: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished.
 - 5. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
 - 6. Shutdown of utility services shall be coordinated by CONTRACTOR, assisted by OWNER as required relative to contacting utility owners.

D. Remediation:

1. Prior to performing demolition Work that disturbs Asbestos, remove and dispose of Asbestos in accordance with Section 02 82 32, Asbestos Abatement.
2. Prior to performing demolition Work involving lead-based paint and/or Non-Liquid PCB Material, remediate in accordance with Section 02 82 33, Lead-Based Paint Abatement and Section 02 83 19, Non-Liquid PCB Material Removal.

3.2 DEMOLITION – GENERAL

A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.

B. Pollution Controls:

1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Section 01 57 05, Temporary Controls, and Laws and Regulations.
2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.
3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work, in accordance with the General Conditions and Section 01 74 05, Cleaning.

C. Comply with Section 01 73 29, Cutting and Patching.

D. Demolition of Site Improvements:

1. Pavement, Sidewalks, Curbs, and Gutters: Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
2. Fencing, Guardrails, and Bollards: Remove to the limits shown or indicated on the Drawings. Completely remove below-grade posts and concrete.
3. Manholes, Vaults, Chambers, and Handholes: Remove to the limits shown or indicated on the Drawings.
4. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes: Remove to the extent shown or indicated on the Drawings. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the “Mechanical Removals” Article in this Section.

G. Salvage and Ownership:

1. Refer to Section 01 11 13, Summary of Work, for requirements on salvage, ownership, and handling of equipment and materials removed during demolition and removal Work.
2. Materials and equipment to remain OWNER’s property shall be carefully removed and appropriately handled by CONTRACTOR to avoid damage and invalidation of warranties in effect, and shall be cleaned and stored at the Site

(or other site specified in the Contract Documents) at place designated by ENGINEER or OWNER.

- H. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and re-finished with materials that match existing adjacent surface, or as otherwise approved by ENGINEER.

3.3 STRUCTURAL REMOVALS

- A. Remove structures to lines and grades shown or indicated, unless otherwise directed by ENGINEER. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at CONTRACTOR's expense and such excess removals shall be reconstructed to satisfaction of ENGINEER without additional cost to OWNER.
- B. Recycling and Reuse of Demolition Materials:
 - 1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by ENGINEER.
 - 2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.
- C. After removing concrete and masonry walls or portions thereof, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.
- D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.
 - 1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
 - 2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
 - 3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 inches below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
 - 4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.

- E. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, remove the anchors to not less than 1.5 inches beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by ENGINEER.
- E. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.
- F. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Section, unless specified elsewhere in the Contract Documents.

3.4 MECHANICAL REMOVALS

- A. Mechanical demolition and removal Work includes dismantling and removing existing piping, ductwork, pumps, equipment, tanks, and appurtenances as shown, indicated, and required for completion of the Work. Mechanical removals include cutting and capping as required, except that cutting of existing piping and ductwork to make connections is included under Section 01 14 16, Coordination with Owner's Operations; Section 01 73 29, Cutting and Patching; and applicable Sections of Division 40, Process Integration.
- B. Demolition and Removals of Piping, Ductwork, and Similar Items:
 - 1. Purge piping and tanks (as applicable) of chemicals or fuel (as applicable) and make safe for removal and capping. Remove to the extent shown or indicated existing process, water, waste and vent, chemical, gas, fuel, and other piping. Remove piping to the nearest solid piping support, and provide caps on ends of remaining piping. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.
 - 2. Caps, Closures, Blind Flanges, and Plugs:
 - a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.
 - b. Where used in this Section, the term "cap" means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.
 - c. Caps shall be compatible with the piping or ductwork to which the cap is attached, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.
 - d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Section only when so shown or indicated in the Contractor Documents or when allowed by ENGINEER.
 - 3. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.

4. Remove waste and vent piping, and ductwork to extent shown and cap as required. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.
 5. Modifications to potable water piping and other plumbing and heating system work shall comply with Laws and Regulations. All portions of potable water system that have been modified or opened shall be hydrostatically tested and disinfected in accordance with the Contract Documents, and Laws and Regulations. Hydrostatically test other, normally-pressurized, plumbing piping and heating piping.
- C. Equipment Demolition and Removals:
1. To the extent shown or indicated, remove existing process equipment; pumps; storage tanks; hoisting and conveying equipment; heating, ventilating, and air conditioning equipment; generators; and other equipment.
 2. Where required, disassemble equipment to avoid imposing excessive loading on supporting walls, floors, framing, facilities, and Underground Facilities. Disassemble equipment as required for access through and egress from building or structure. Disassembly shall comply with Laws and Regulations. Provide required means to remove equipment from building or structure.
 3. Remove control panels, operator stations, and instruments associated with equipment being removed, unless shown or indicated otherwise.
 4. Remove fuel appurtenances as applicable, including fuel storage tanks. Dispose of tank contents in accordance with Laws and Regulations.
 5. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the "Structural Removals" Article in this Section. Remove small-diameter piping back to header unless otherwise indicated.
 6. Remove access platforms, ladders, and stairs related to equipment being removed, unless otherwise shown or indicated.

3.5 ELECTRICAL REMOVALS

- A. Electrical demolition Work includes removing existing transformers, distribution switchboards, control panels, motors, starters, conduit and raceways, cabling, poles and overhead cabling, panelboards, lighting fixtures, switches, and miscellaneous electrical equipment, as shown, specified, or required.
- B. Remove existing electrical equipment and fixtures to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
- C. Remove or modify motor control centers and switchgear as shown or indicated. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.

- D. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated. Motors, microprocessors and electronics, other electrical gear to be reused shall be stored in accordance with Section 01 66 00, Product Storage and Handling Requirements.
- E. Cables in conduits to be removed shall be removed back to the power source or control panel, unless otherwise shown or indicated. Verify the function of each cable before disconnecting and removing.
- F. Conduits, raceways, and cabling shall be removed where shown or indicated. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to ENGINEER. Exposed conduits, junction boxes, other electrical appurtenances, and their supports shall be disassembled and removed. Repair all areas of the Work to prevent rusting on exposed surfaces.
- G. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
- H. Where shown or indicated, remove direct burial cable. Openings in buildings for entrance of direct burial cable shall be patched with repair mortar or other material approved by ENGINEER for this purpose, and made watertight.
- I. Existing poles and overhead cables shall be removed or abandoned as shown and specified. Existing substation(s) and poles owned by electric utility will be removed by the electric utility. Completely remove from the Site poles not owned by electric utility and shown or indicated for removal. Make necessary arrangements with electric utility for removal of utility company's transformers and metering equipment after new electrical system has been installed and energized.
- J. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as OWNER's property, shall be removed and properly disposed off-Site as required.

3.6 DISPOSAL OF DEMOLITION DEBRIS

- A. Remove from the Site all debris, waste, rubbish, and material resulting from demolition operations and equipment used in demolition Work. Comply with the General Conditions, Supplementary Conditions, and Section 01 74 05, Cleaning.
- B. Transportation and Disposal:
 - 1. Non-hazardous Material: Properly transport and dispose of non-hazardous demolition debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Asbestos, PCBs, Petroleum, Hazardous Waste, Radioactive Material, or other material designated as hazardous in Laws and Regulations.

2. Hazardous Material: When handling and disposal of hazardous materials is included in the Work, properly transport and dispose of hazardous materials in accordance with the Contract Documents and Laws and Regulations.
- C. Submit to ENGINEER information required in this Section on proposed facility(ies) where demolition material will be recycled. Upon request, ENGINEER or OWNER, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist ENGINEER and OWNER.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 02 82 32
ASBESTOS ABATEMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, equipment, tools, materials, notifications, and permits required to remove and dispose of asbestos-containing materials (ACM) as required to complete the Work. This includes providing notification to the commissioner of Public Health prior to engaging in any asbestos abatement which involves more than ten linear feet or 25 square feet of ACM. The Work includes:
 - a. Sample collection, testing, analysis, and reporting of ACM.
 - b. Removal and disposal of ACM.
2. This Section describes procedures and equipment required to protect workers and occupants of the work area from contact with airborne asbestos fibers and ACM dust and debris. The Work also includes the disposal of generated ACM wastes. The CONTRACTOR shall submit more specific operational procedures to perform the Work in the required Asbestos Hazard Abatement Plan (AHAP) as specified in paragraph 1.4.C. of this Section.

B. Related Sections

1. Section 02 41 00, Demolition
2. Section 02 82 33, Lead- Based Paint Abatement

1.2 REFERENCES

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.

1. ANSI Z87.1- 1989 Occupational and Educational Eye and Face Protection.
2. ANSI Z88.2- 1980 Practices for Respiratory Protection
3. ANSI Z9.2 - 1979 Exhaust Systems, Design and Operations
4. ASTM D 1331- 1989; R 2001 Standard Test Methods for Surface and Interfacial Tension of Solutions of Surface-Active Agents

5. ASTM D 4397 - 1984; R 1989 Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
6. ASTM E 84- 1991a Surface Burning Characteristics of Building Materials.
7. ASTM E 119- 1988 Fire Tests of Building Construction and Materials
8. ASTM E 1368- 05 Visual Inspection of Asbestos Abatement Projects
9. 29 CFR Part 1910 - Occupational Safety and Health Standards
10. 29 CFR Part 1926 - Safety and Health Regulations for Construction
11. 40 CFR Part 61- National Emissions Standards for Hazardous Air Pollutants
12. 40 CFR Part 763 - Asbestos
13. 49 CFR Parts 106 - Transportation Standards 107, 171 to 180
14. EPA 340/1-90-018 - 1990 Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance.
15. EPA 340/1-90-019 - 1990 Asbestos/NESHAP Adequately Wet Guidance.
16. EPA 560/5-85-024 - 1985 Guidance for Controlling Asbestos Containing Materials in Building
17. NFPA 10 - 1988 Portable Fire Extinguishers
18. NFPA 70 - 1990 National Electrical Code
19. NFPA 90A - 1989 Installation of Air Conditioning and Ventilating Systems
20. NFPA 101 - 1991 Safety to Life from Fire in Buildings and Structures
21. NFPA 701 - 1989 Methods of Fire Test for Flame-Resistant Textiles and Films
22. NIOSH Pub No. 84-100 - 1984; Supple. 1985, 1987, 1988 & 1990) NIOSH Manual of Analytical Methods
23. UL 586 - 1990 High-Efficiency, Particulate, Air Filter Units
24. RCSA 19a-332a – Standards for Asbestos Abatement

25. RCSA 20-440 – Licensure and Training Requirements for Persons Engaged in Asbestos Abatement and Consultation Service

1.3 DEFINITIONS

- A. Adequately Wet: A term as defined in 40 CFR Part 61, Subpart M and EPA 340/1-90-019 that means to sufficiently mix or penetrate with liquid to prevent the release of particulates. If visible emissions are observed coming from asbestos-containing material (ACM), then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wetted.
1. Amended Water: Water containing a wetting agent or surfactant with a surface tension of at least 29 dynes per square centimeter when tested in accordance with ASTM D 1331.
 2. Asbestos: Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that has been chemically treated and/or altered.
 3. Asbestos Containing Material (ACM): Any material containing more than 1 percent asbestos as determined using the method specified in 40 CFR Part 763, Appendix A, Subpart F, Section 1, Polarized Light Microscopy.
 4. Certified Industrial Hygienist (CIH): One certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene.
 5. Class I Asbestos Work: Activities involving the removal of thermal systems insulation, surfacing ACM and PACM.
 6. Class II Asbestos Work: Means activities involving the removal of ACM, which is not thermal system insulation or surfacing material. This includes, but is not limited the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.
 7. Class III Asbestos Work: Means repair and maintenance operations, where “ACM”, including TSI and surfacing ACM and PACM, may be disturbed.
 8. Class IV Asbestos Work: Means maintenance and custodial activities during which employees contact but do not disturb ACM and PACM and activities to clean up dust, waste and debris resulting from Class I, II, and III.
- B. Competent Person: In addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f). In addition, for Class I and Class II work, one who is specially trained in a training course

that meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor, or its equivalent; for Class II roofing work who is specially trained in a comprehensive course for the roofing trade that has been conducted by an EPA or state approved trainer, certified by the EPA or MDCIS; and for Class II and IV work, who is trained in an operations and maintenance (O&M) course developed by EPA 40 CFR 763.92 (a)(2).

- C. Friable ACM: A term as defined in CFR 40 Part 61, Subpart M and EPA 340/1-90-018 that means any ACM material that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.
- D. High-Efficiency Particulate Air (HEPA) Filter: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter (a.k.a., P-100 filter).
- E. Industrial Hygienist (IH): A professional qualified by education, training, and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards.
- F. Negative Pressure Enclosure (NPE): An asbestos abatement regulated area in which critical barriers, polyethylene sheeting walls and floor are installed and sealed air-tight. A minimum pressure differential of minus 0.02 inches of water column relative to adjacent unsealed areas and four air changes per hour is to be maintained within the area continuously 24 hours per day.
- G. Non-Friable ACM: A term as defined in CFR 40 Part 61, Subpart M and EPA 340/1-90-018 that means asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products.
- H. Non-Friable ACM Category I: A term as defined in CFR 40 Part 61, Subpart M and EPA 340/1-90-018 that means any ACM material, excluding Category 1 non-friable ACM that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
- I. PACM: "Presumed ACM" which is thermal system insulation and surfacing material found in buildings constructed no later than 1980. The designation of a material as "PACM" may be rebutted pursuant to paragraph (k)(4) of section 1926.1101.
- J. Professional: OWNER'S Agent who is licensed as an asbestos project monitor by the State of Connecticut.
- K. Regulated Area: An area established by the employer to demarcate areas where Class I, II, and III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work accumulate; and a work area within which airborne concentrations of asbestos, exceed or there is a reasonable possibility they may exceed the permissible exposure limit. Requirements for regulated areas are set out in paragraph (e) (6) of 29 CFR 1926.1101.

- L. Thermal System Insulation (TSI): ACM applied to pipes, fittings, boilers, breaching, tanks, ducts or other structural components to prevent heat loss or gain. Thermal system insulation ACM is thermal system insulation which contains more than 1% asbestos. Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that has been chemically treated and/or altered. For purposes of this standard, "asbestos" includes PACM, as defined above.

1.4 SUBMITTALS

- A. Shop Drawings and brochures shall be submitted for all items to be furnished in accordance with the applicable provisions.
- B. An Asbestos Hazard Abatement Plan (AHAP) shall be submitted by the CONTRACTOR a minimum of 10 days prior to the start of asbestos abatement work at the site.
- C. Asbestos Hazard Abatement Plan (AHAP): A detailed plan of the response actions to be taken, ACM items to be abated and method of abatement for each abatement work task and the control procedures to be used in the abatement of the ACM. The AHAP shall take into consideration all the individual ACM abatement work tasks as summarized in Appendix A. The AHAP shall be prepared by, signed and sealed including certification number and dated by the CONTRACTOR'S Certified Industrial Hygienist (CIH). The AHAP shall include, but not be limited to, a detailed personal air monitoring plan, personal protective equipment to be used, the location of asbestos regulated work areas, including clean and dirty areas, access tunnels, decontamination unit (clean room, shower room, equipment room, storage areas such as load-out unit), abatement method, interface of trades involved in the construction, sequencing of asbestos related work, disposal procedures and plan, type of wetting agent and asbestos encapsulant to be used, planned air monitoring strategies, and a detailed description of the method to be employed in order to control the spread of ACM wastes and airborne fiber concentrations. The AHAP shall also include both fire and medical emergency response procedures and the specific security procedures to be used for all asbestos regulated work areas. The CONTRACTOR shall not begin work in areas containing ACM until the OWNER has accepted the AHAP in writing.
 - 1. Site Layout Drawings: Detailed project drawings showing site layout to include work site boundaries, work site control methods, location of decontamination units, temporary waste storage facility, location of temporary utilities, water supply and portable temporary toilets, and location of temporary electrical panel with Ground-Fault Circuit Interrupters (GFCIs).
 - 2. Qualifications: A written qualifications and organization report providing evidence of qualifications of the CONTRACTOR, CONTRACTOR'S on-site supervisor (competent person), CONTRACTOR workers, all subcontractors (to include disposal transportation and disposal facility firms), subcontractor

supervisors, subcontractor workers, independent Industrial Hygienist (IH) firm, independent testing laboratory, and testing laboratory analysts, to perform asbestos abatement activities as required herein. The report shall specify the CONTRACTOR'S staff organization to include subcontractors, CIH and testing laboratory firms and certify that all firms and personnel involved in the asbestos abatement project fully understand the contents of 29 CFR Part 1926, 40 CFR Part 61, Subparts M, and the Federal, state and local requirements. The CONTRACTOR'S qualification report shall contain information required below:

- a. Evidence that CONTRACTOR'S full-time, on-site supervisor is designated as, and is qualified to be a "competent person" in accordance with 29 CFR Part 1926 and is experienced in the administration and supervision of asbestos abatement project, including work practices, abatement methods, protective measures for personnel, inspection of asbestos abatement work areas, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements. This designated "competent person" on-site supervisor shall be responsible for compliance with applicable Federal, state and local requirements, and have a minimum of 2 years of on-the-job asbestos abatement supervisory experience, and be licensed by the State of Connecticut as an asbestos abatement supervisor.
- b. Evidence that the laboratory performing asbestos bulk sample and air sample collection, testing, analysis, and reporting is certified by the State of Connecticut.
- c. The name, address and telephone number of each independent testing laboratory selected to perform the sample analyses and report the results of the CONTRACTOR'S personal air samples. The testing laboratory shall be completely independent from the CONTRACTOR as recognized by Federal, state or local regulations. For each laboratory selected to conduct phase contrast microscopy (PCM) of airborne samples using the methods specified by 29 CFR Part 1926 and NIOSH Pub No.84-100 Method 7400 as required by CFR 40 Part 61, Subpart M written verification of the following criteria, signed by the Testing Laboratory principal and the CONTRACTOR shall be submitted:
 - 1) The laboratory is currently judged proficient in counting airborne asbestos samples by PCM by successful participation within the past year in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program.
 - 2) The name of each selected microscopist who will analyze airborne samples by PCM with substantiating verification that

such person possesses the demonstrated proficiency to conduct PCM analysis by; being judged proficient in counting samples as a current participating analyst in the AIHA PAT Program, and having successfully completed the Asbestos Sampling and Analysis course (NIOSH 582 or equivalent; a copy of course completion certificate is required). When the PCM analysis is to be conducted on site, written documentation shall be provided certifying that the on-site analyst meets the same requirements.

- 3) The laboratory is fully equipped and each analyst possesses demonstrated proficiency to confirm NIOSH Pub No. 84-100 Method 7400 PCM sample analyses results from the same filter by conducting NIOSH Pub No. 84-100 Method 7402 TEM analyses.
 - 4) The laboratory is fully equipped to conduct polarized light microscopy (PLM) analysis of suspect ACM bulk samples in accordance with CFR 40 Part 61, Subpart M and the laboratory is currently accredited by the National Institute for Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) for bulk asbestos analysis will use analysts (provide name(s)) with demonstrated proficiency to conduct PLM to include its application to the identification and quantification of asbestos content.
- d. Designated Industrial Hygienist Qualifications: The name, address, telephone number, and resume of the CIH selected to prepare the AHAP, perform training, direct personal air monitoring and assist the CONTRACTOR'S competent person supervisor in implementing and ensuring safety and health requirements are complied with during the performance of all required work. The CIH shall be a person who is board certified in comprehensive practice as determined and documented by the American Board of Industrial Hygiene (ABIH), and has a minimum of 2 years of comprehensive experience in planning and overseeing asbestos abatement activities. The CIH shall be completely independent from the CONTRACTOR and shall not be an employee of the CONTRACTOR or be an employee or principal of a firm recognized by federal, state, or local regulations that would constitute a business relationship that would not be considered independent. A copy of the CIH's current valid ABIH certificate shall be included. The designated CIH shall prepare and the CONTRACTOR shall submit the name, address, telephone number, and resumes of additional industrial hygienists (IHS) who will be assisting the designated CIH in performing on-site tasks.

- e. Landfill and Transporter Qualifications: Written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA, state and local regulatory agencies. Copies of signed agreement between the CONTRACTOR, and each subcontractor to include transporters and the asbestos waste disposal facility to accept and dispose of all asbestos containing waste generated during the performance of this contract.
- f. Employee Training and Certification of Worker Acknowledgment: The following training documentation for each employee to be engaged in the abatement work who will be potentially exposed to asbestos as determined by their direct handling of the material, entrance into an asbestos regulated work area, or airborne exposure in excess of 0.1 fibers per cubic centimeter of air (f/cc) measured as an 8-hour time-weighted average (TWA):
 - 1) Copy of certification of accreditation for completion of “workers” course (for workers) or “CONTRACTOR/Supervisor Course” (for CONTRACTOR’S on-site supervisory staff) meeting the requirements of EPA’s CFR 40 Part 763 or more stringent state criteria, and all subsequent annual refresher training certificates meeting same requirements.
 - 2) A copy of the Certificate of Workers Acknowledgment shall be completed for each employee in the same format and containing the same information as the example certificate found in Appendix A.
- g. Training Material: A copy of the written project site-specific training material prepared to comply with 29 CFR Part 1926, Section 1926.1101 that will be used to train all on-site employees. This training document shall be signed by the CONTRACTOR’S CIH and competent person supervisor.
- h. Certification of Medical Requirements: For each worker, a written medical opinion prepared and signed by a licensed physician indicating the following:
 - 1) The name and social security number of the employee.
 - 2) A copy of the employee’s medial examination results, including the medical history, questionnaire responses, results of any tests, and physician’s recommendations.
 - 3) Physician’s written opinions, including approval to wear a respirator during work activities.

- 4) Any employee medical complaints related to exposure to asbestos.
 - 5) A copy of the information provided to the physician as required by 29 CFR Part 1926, Section 1926.1101.
- D. **Materials and Equipment:** The CONTRACTOR shall submit all manufacturer's catalog data for all materials and equipment to be used in the Work, including brand name, model, capacity, performance characteristics and any other pertinent information. This submittal shall include Material Safety Data Sheets (MSDS) for all chemicals to be used onsite in the same format as implemented in the CONTRACTOR'S Hazard Communication Program. Include manufacturer's certifications showing compliance with ANSI Z9.2 for vacuums, water filtration equipment and other equipment required to contain airborne asbestos fibers.
- E. **Air Sampling Results:** Personal air sample fiber counting shall be completed and results provided to the OWNER within 24 hours after completion of a sampling period. The OWNER shall be notified immediately of any airborne levels of asbestos fibers in excess of established requirements. Written sampling results shall be provided within 5 working days of the date of collection. The written results shall be signed by testing laboratory analyst, testing laboratory principal, and the CONTRACTOR'S CIH. The air sampling results shall be documented on a CONTRACTOR'S daily air monitoring log. The daily air monitoring log shall contain the following information for each sample: date sample collected, date sample analyzed, sample number, sample type, sample period (start time, stop time), sampling pump manufacturer - model and serial number, average flow rate (liters per minute (L/min)), total air volume sampled (liters (L)), results (fibers per cubic centimeter (f/cc)) and location/activity/name where sample collected. In addition, the daily log shall identify the calibration method used to calibrate the sampling pumps, the name and location of the laboratory conducting the sample analyses, print name, signature, and date block for the industrial hygienist who conducted the sampling and the review verifying the accuracy of the information.
- F. **Asbestos Waste Shipment:** Final completed copies of the Waste Shipment Record for all shipments of waste material as specified in 40 CFR Part 61, Subpart M and other required state waste manifest shipment records as specified herein. Detailed information of all asbestos waste disposal on the "MANDATORY WASTE SHIPMENT RECORD" form in accordance with revised 40 CFR Part 61, Subpart M. Such completed forms signed and dated by the agent of the landfill shall be submitted within 3 days after date of delivery of ACM to the landfill.

1.5 SECURITY

- A. A log book shall be kept documenting entry into and out of the asbestos regulated work area. Entry into asbestos regulated work areas shall only be by personnel authorized by the CONTRACTOR and the OWNER. Personnel authorized to enter asbestos

regulated work areas shall be trained, medically evaluated and wear the personal protective equipment, as required by 29 CFR 1926.1101 and this specification, for the specific asbestos regulated work area to be entered.

1.6 MEDICAL REQUIREMENTS

- A. Medical requirements shall conform to 29 CFR Part 1926, Section 1926.1101 (asbestos) and Part 1910, Section 1910.120 (Hazardous Waste Operations).
- B. Medical Examinations: Before entering the site, all asbestos abatement personnel shall have successfully completed a comprehensive medical examination as required by 29 CFR Sections 1926.1101 and 1910.120 and other pertinent state or local requirements.
- C. Medical and Exposure Records: Complete and accurate records shall be maintained of each employee's medical examinations, medical records and exposure data as required by 29 CFR, Section 1926.1101 for a period of 30 years after termination of employment. The CONTRACTOR may utilize the services of competent organizations such as industry trade associations and employee associations to maintain the records required by this specification. A copy of the required medical certification for each employee shall be maintained on file at the work site for review as requested by the OWNER.

1.7 TRAINING

- A. Within 1 year prior to assignment and commencement of Work on this asbestos abatement project, each worker directly involved in handling ACM and ACM generated wastes including packaging and transporting such wastes for disposal, shall have successfully completed a course of asbestos training as required by the State of Connecticut under RCSA 20-440, and U. S. Environmental Protection Agency's (EPA) revised Asbestos Model Accreditation Plan (MAP), as mandated by the Asbestos School Hazard Abatement Reauthorization Act (ASHARA). All persons involved in the project shall be currently certified by the State of Connecticut. In addition, prior to the commencement of Work, each worker shall be instructed by the CONTRACTOR'S industrial hygienist and onsite "competent person" supervisor in the following project specific training: The hazards and health effects of the specific types of ACM to be abated; the content and requirements of the Asbestos Hazard Abatement Plan; work practices; the use requirements and limitations of the personal protective clothing, equipment, and respirators to be used; hands-on-training for each asbestos abatement technique to be employed; heat and/or cold stress monitoring specific to this Project; personal hygiene and housekeeping requirements; air monitoring procedures; and all additional requirements of 29 CFR Part 1926, Section 1926.1101.
- B. CONTRACTOR shall maintain all employee training records for one year beyond the last date of employee's employment by that CONTRACTOR. The CONTRACTOR may utilize the services of competent organizations such as industry trade associations and employee associations to maintain the records required by this specification. A

copy of the required training records and fit test certificates for each employee shall be maintained on file at the work site for review as requested by the OWNER.

1.8 SAFETY AND HEALTH COMPLIANCE

- A. In addition to the requirements of this specification, the Work shall comply with applicable laws, ordinances, criteria, rules, and regulations of Federal, state, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials and with the applicable requirements of 29 CFR Part 1910, 29 CFR Part 1926, 40 CFR Part 61, Subpart A, and 40 CFR Part 61, Subpart M, NFPA 10, NFPA 70, NFPA 90A, NFPA 101. All work shall be conducted in accordance with applicable State and local regulations. Matters of interpretation of standards shall be submitted to the appropriate administrative agency for resolution before starting Work. Where the requirements of this specification, applicable laws, rules, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirement as defined by the OWNER shall apply.

1.9 COMPETENT PERSON

- A. The CONTRACTOR shall designate a Competent Person, having the qualifications and authorities for ensuring worker safety and health required by Subpart C, General Safety and Health Provisions for Construction (29 CFR 1926.20 through 1926.32). The Competent Person shall conduct frequent and regular inspections of the job sites, materials, and equipment as required by 29 CFR Part 1926, Section 1926.20 and as described below.
- B. The Competent Person shall perform or supervise the following duties, as applicable:
1. Set up the regulated area, enclosure, or other containment.
 2. Supervise all employee exposure monitoring.
 3. Ensure that employees working within the regulated area wear protective clothing and respiratory protection.
 4. Ensure through on-site supervision, that employees use work practices and personal protective equipment in compliance with all requirements.
 5. Ensure that employees use the hygiene facilities and observe the decontamination procedures.
- C. The Competent Person shall be trained in all aspects of asbestos removal and handling, including: Abatement, installation, removal and handling; the contents of this standard; the identification of asbestos; removal procedures, where appropriate; and other practices for reducing the hazard. Such training shall be obtained in a comprehensive course for supervisors, such as a course conducted by an EPA or

state-approved training provider, certified by the EPA or a state, or a course equivalent in stringency, content, and length.

1.10 INDUSTRIAL HYGIENIST (IH)

- A. Personal air sampling shall be conducted as described in paragraph 3.12 by an IH under the supervision of a CIH experienced in asbestos abatement.

1.11 PERMITS, LICENSES AND NOTIFICATIONS

- A. Necessary permits and licenses shall be obtained in conjunction with the project asbestos abatement, transportation and disposal actions and timely notification furnished of such actions required by Federal, state, regional, and local authorities and as otherwise specified herein. The CONTRACTOR shall advise appropriate Federal, State and Local Authorities in writing at least 10 working days prior to the commencement of work in accordance with CFR 40 Part 61, Subpart M, state and local requirements. This work shall include the mandatory "Notification of Intent to Renovate/Demolish" form and other required notification documents.

PART 2 - PRODUCTS

2.1 PERSONAL PROTECTIVE EQUIPMENT

- A. CONTRACTOR workers shall be provided with personal protective clothing and equipment as specified herein and the CONTRACTOR shall ensure that it is worn properly. The CONTRACTOR'S CIH and designated competent person supervisor shall select and approve all the required personal protective clothing and equipment to be used.
- B. Respirators: Respirators shall be selected and used in accordance with manufacturers recommendations, 29 CFR Part 1926, Section 1926.1101, and shall be approved by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (MSHA/NIOSH) for use in environments containing airborne asbestos fibers. Personnel who handle ACM, enter asbestos regulated work areas that require the wearing of a respirator, or who are otherwise carrying out abatement activities that require the wearing of a respirator, shall be provided with approved respirators that are fully protective of the worker at the measured or anticipated airborne asbestos concentration level to be encountered. For air-purifying respirators, the particulate filter portion of the cartridges or canister approved for use in airborne asbestos environments shall be Type H, high-efficiency particulate air (HEPA). As a minimum a powered-air purifying respirator (PAPR) equipped with HEPA cartridges shall be worn during the startup of abatement activities, unless otherwise approved in writing by the CIH. The upgrading or downgrading of respirator type, from the minimum requirements specified for start-up, shall be made by the CONTRACTOR'S CIH based on the measured or anticipated airborne asbestos fiber concentrations to be

encountered. Respiratory protection shall comply with the 29 CFR Part 1926, CFR 11 Part 30, and 29 CFR Part 1910.

A qualitative or quantitative fit test conforming to 29 CFR Part 1926, Appendix B, shall be conducted by the CONTRACTOR'S competent person or IH for each worker required to wear a respirator, and for the OWNER and authorized visitors who enter an asbestos regulated work area where respirators are required to be worn. A respirator fit test shall be performed for each worker prior to initially wearing a respirator on this project and annually thereafter. If physical changes in a worker develop that will affect the fit, or a new size, make, or model of respirator is used, a new fit test shall be performed. Functional fit checks shall be performed by employees each time a respirator is put on and in accordance with the manufacturer's recommendation.

C. Whole Body Protection: Personnel exposed to asbestos shall be provided with whole body protection as specified herein and such protection shall be worn properly. The CONTRACTOR'S CIH and competent person supervisor shall select and approve the whole body protection to be used. Disposable whole body protection shall be disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area. Reusable whole body protection worn shall be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly laundered in accordance with 29 CFR Part 1926 and the approved AHAP. Asbestos abatement whole body protection shall not be removed from the work site.

1. Coveralls: Disposable - Zippered front coveralls with attached head and foot coverings, shall be provided. Sleeves shall be secured at the wrists.
2. Gloves: Disposable plastic or rubber gloves shall be provided to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Where there is the potential for hand injuries (i.e., scrapes, punctures, cuts) a suitable outer glove shall be provided and used.
3. Under Clothing: Disposable underwear shall be provided and worn next to the skin or cloth under clothing.
4. Work Clothing: An additional coverall shall be provided when the abatement and control method employed does not provide for the exit from the asbestos regulated work area directly into an attached decontamination unit. Cloth work clothes shall be provided for wear under the protective coverall and foot coverings when work is being conducted in low temperature conditions. Cloth work clothes shall be either disposed of as asbestos contaminated material or properly laundered in accordance with 29 CFR Part 1926 and as specified in the approved AHAP.
5. Foot Coverings: Cloth socks shall be provided and worn next to the skin. If rubber boots are not used, foot wear and disposable foot coverings shall be provided. Rubber boots shall be used in moist or wet areas. Only rubber boots

shall be removed from the asbestos regulated work area after being thoroughly decontaminated. All other protective foot covering shall be disposed of as ACM.

6. Head Covering: Hood type disposable head covering shall be provided. In addition, protective head gear (hard hats) shall be provided as required. Hard hats shall only be removed from the asbestos regulated work area after being thoroughly decontaminated.
7. Protective Eye Wear: Contact lenses shall not be worn in asbestos regulated work areas. When vision correction is necessary to perform the work task, prescription safety eye wear shall be used. Safety glasses shall be worn by personnel engaged in asbestos abatement activities in the asbestos regulated work area when the use of a full face-piece respirator is not required. Eye protection provided shall be in accordance with ANSI Z87.1. Eye wear shall only be removed from the asbestos regulated work area after being thoroughly decontaminated.
8. Other Items: All other items of whole body protection shall be provided as required and approved by the CONTRACTOR'S CIH.

2.2 DECONTAMINATION

- A. A temporary decontamination unit shall be provided for all Class I abatement activities in which greater than 25 linear feet or 10 square feet are removed from a regulated area. Decontamination units shall be adjacent and contiguous with the regulated area. Remote decontamination units may be used only if adjacent decontamination units are not feasible. Utilization of prefabricated units or remote units shall be reviewed by the CONTRACTOR'S CIH and the Professional will make final review/approval. All remote decontamination systems shall be in accordance with RCSA 19a-332a-6(c) and (d). Decontamination unit shall be attached in a leak-tight manner to each asbestos regulated work area. The decontamination unit shall have a separate equipment locker room and a clean locker room with a shower in between (complying with 29 CFR Part 1910.141 and RCSA 19a-332a-6(a)). Upon exiting from the asbestos regulated work area to the equipment room, respirators shall be worn while asbestos contaminated protective clothing is HEPA-vacuumed, removed, and placed in approved labeled containers for disposal.
- B. Workers shall shower before changing into street clothes. Used shower water shall be collected and filtered to remove asbestos contamination. Filters and residue shall be disposed of as asbestos contaminated material. Filtered water shall be discharged to the sanitary system after written approval from the applicable utility or trucked off site. Hot water service will be provided by the CONTRACTOR. The CONTRACTOR shall provide a minimum 150 liters (40 gallon) electric hot water heater with minimum recovery rate of 75 liters (20 gallons) per hour and a temperature controller for each showerhead. Instantaneous type in-line water heater may be incorporated at each

shower head in lieu of hot water heaters upon approval by the CIH. Flow and temperature controls shall be located within the shower and be adjustable by the user. The wastewater pump shall be sized for 1.25 times the showerhead flow-rate at a pressure head sufficient to satisfy the filter head loss and discharge line losses. The pump shall supply a minimum 1.6 liters per second (25 gallons per minute) flow with 11 m. (35 ft.) of pressure head. Wastewater filters shall be installed in series with the first stage pore size of 50 micrometer (microns) and the second stage pore size of 5 micrometer (microns).

- C. The floor of the decontamination unit's clean room shall be kept dry and clean at all times. Water from the shower shall not be allowed to wet the floor in the clean room. Surfaces of the clean room and shower shall be wet-wiped two times after each shift change with a disinfectant solution. Proper housekeeping and hygiene requirements shall be maintained. Soap, shampoo, and clean towels shall be provided for showering, washing and drying in sufficient quantities to accommodate the number of abatement workers present. Any cloth towels provided shall be disposed of as ACM waste or be laundered in accordance with 29 CFR Part 1926 and the approved AHAP. Surfaces of the equipment room shall be wet-wiped two times after each shift change. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

2.3 WARNING SIGNS AND TAPE

- A. CONTRACTOR shall ensure that all personnel understand the warning signs. Warning signs and tape shall be provided at the regulated boundaries and entrances to asbestos regulated work areas. Signs shall be located at a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Warning signs shall conform to 29 CFR Part 1926.58(k)(1)(ii). All warning signs shall be written in English and the predominant language spoken by the workers if English is not spoken.

2.4 WARNING LABELS

- A. Warning labels shall be affixed to all asbestos disposal containers used to contain asbestos materials, scrap, waste debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to requirements specified herein are acceptable. Warning labels shall conform to 29 CFR Part 1926 and shall be of sufficient size to be clearly legible displaying the following legend:

DANGER

CONTAINS ASBESTOS FIBERS

AVOID CREATING DUST

CANCER AND LUNG DISEASE

HAZARD

**BREATHING AIRBORNE ASBESTOS FIBERS IS HAZARDOUS TO
YOUR HEALTH**

Transportation labels shall be affixed to all asbestos disposal containers used to contain asbestos materials, scrap, waste debris, and other products contaminated with asbestos and shall state:

RQ, Asbestos, NA 2212, Class 9.

Generator labels shall be affixed to all asbestos disposal containers used to contain asbestos materials, scrap, waste debris, and other products contaminated with asbestos. Generator labels shall include the name, address, and telephone number of the owner/generator of the waste.

2.5 TOOLS AND LOCAL EXHAUST SYSTEM

- A. Vacuums shall be leak-proof to the filter, equipped with HEPA filters, be of sufficient capacity and provide the necessary capture velocity at the nozzle or nozzle attachment to efficiently collect, transport and retain the ACM waste material. Power tools shall not be used to remove ACM unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation capture and collection system or has otherwise been approved for use by the Professional. All residual asbestos shall be removed from reusable tools prior to storage and reuse. Reusable tools shall be thoroughly decontaminated prior to being removed from asbestos regulated work areas in accordance with RCSA 19a-332a-7(d) and (e).
- B. Provide a local exhaust system in NPE's. The local exhaust system shall be in accordance with ANSI Z9.2. Air filtration devices shall have high efficiency particulate air (HEPA) filters. The number of air filtration devices must be sufficient to maintain a minimum pressure differential of minus 0.02 inch of water column relative to adjacent, unsealed areas and four air changes per hour. Provide continuous 24-hour per day monitoring of the pressure differential. Filters on vacuum and exhaust equipment shall conform to ANSI Z9.2. CONTRACTOR shall open units to verify filter integrity at job start. CONTRACTOR shall use new flex duct for local exhaust system and one flex duct per HEPA unit. CONTRACTOR shall replace filters for air filtration devices in accordance with manufacturer's recommendations and in accordance with RCSA 19a-332a-7(f).
- C. CONTRACTOR shall be responsible for obtaining any and all licenses and paying all fees that are associated with existing patent(s) on asbestos exhaust systems.

2.6 RENTAL EQUIPMENT

- A. If rental equipment is to be used, written notification shall be provided to the rental agency, concerning the intended use of the equipment, the possibility of asbestos contamination of the equipment and the steps that will be taken to decontaminate such

equipment. A written acceptance of the terms of the CONTRACTOR'S notification shall be obtained from the rental agency and a copy provided to the OWNER.

2.7 EXPENDABLE SUPPLIES

- A. Glove Bag: Glove bags shall be provided as described in 29 CFR Part 1926. The glove bag assembly shall be prefabricated of 6 mil thick transparent polyethylene or polyvinyl chloride sheeting with preprinted OSHA warning label and shall typically be constructed of at least two inward projecting long sleeves and an internal pouch. The glove bag shall be constructed and installed in such a manner that it surrounds the object or material to be removed and contains all asbestos fibers released during the process. The glove bag shall have sufficient capacity to hold removed materials and permit leak-tight sealing.
- B. Duct Tape: Industrial grade duct tape shall be provided in 2 inch and 3 inch widths and shall be suitable for bonding sheet plastic and disposal containers specified herein.
- C. Disposal Containers: Leak-tight disposal containers shall be provided for ACM generated wastes as specified herein. Leak-tight means that solids, liquids or dust cannot escape or spill out. All disposal containers shall be either pre-labeled or affixed with OSHA warning label as specified in 29 CFR Part 1926.
- D. Disposal Bags: 6 mil thick or thicker leak-tight pre-labeled (OSHA warning label) bags shall be provided for placement of asbestos generated waste.
- E. Leak-tight Wrapping: Two layers of 6 mil (minimum) thick polyethylene sheet stock shall be used for the containment of removed asbestos-containing components or materials such as reactor vessels, large tanks, boilers, insulated pipe segments and other materials too large to be placed in disposal containers. Upon placement of the ACM component or material, each layer shall be individually leak-tight sealed with duct tape.
- F. Fiberboard Drums: Fiberboard drums shall be provided if required by state or local requirements.
- G. Sheet Plastic: Sheet plastic shall be provided as specified herein and in the largest sheet size necessary to minimize seams, as indicated on the project drawings.
 - 1. Six mil (minimum) thick polyethylene film shall be clear or frosted and conform to ASTM D 4397.
 - 2. Polyethylene Sheet: Polyethylene sheet, 6-mil (minimum) thick shall be provided.
- H. Wetting Agents:

1. Amended Water: Amended water shall meet the requirements of ASTM D 1331.
2. Removal Encapsulant: Removal encapsulant (a penetrating encapsulant) shall be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant shall be capable of wetting the ACM and retarding fiber release during disturbance of the ACM equal to or greater than provided by amended water.

2.8 MATERIAL SAFETY DATA SHEETS (MSDS)

- A. MSDS shall be provided for all hazardous materials brought onto the work-site. One copy shall be provided to the OWNER and one copy shall be included in the CONTRACTOR'S Hazard Communication Program.

2.9 OTHER ITEMS

- A. A sufficient quantity of other items shall be provided that may include, but not be limited to: scrapers, brushes, brooms, staple guns, tarpaulins, shovels, rubber squeegees, dust pans, other tools, scaffolding, staging, enclosed chutes, non-conductive ladders, lumber necessary for the construction of asbestos regulated containment work areas, UL approved temporary electrical equipment, material and cords, ground fault circuit interrupters (GFCIs), water hoses of sufficient length, fire extinguishers, first aid kits, portable toilets, logbooks, log forms, markers with indelible ink, spray paint in bright color to mark areas and project boundary fencing.

PART 3 – EXECUTION

3.1 ASBESTOS SAMPLING AND ANALYSIS

- A. Sample collection, testing, analysis, and reporting shall be performed by a laboratory certified by the State of Connecticut for asbestos sample collection and analysis. All asbestos bulk sample collection must be performed by a Connecticut-licensed asbestos inspector, and all work area asbestos air monitoring (excluding OSHA personal monitoring) must be performed by a Connecticut-licensed asbestos project monitor.

3.2 GENERAL

- A. Asbestos abatement work shall be performed as specified herein and in accordance with RCSA 19a-332a-7. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, or applying cosmetics shall not be permitted in the asbestos regulated work areas. All hot work (burning, cutting,

welding) shall be conducted under strictly controlled conditions in conformance with 29 CFR Part 1926. Personnel of other trades not engaged in asbestos abatement activities shall not be exposed at any time to airborne concentrations of asbestos unless all the administrative and personal protective provisions as required herein are complied with. If an asbestos spill occurs outside of the asbestos regulated work area, work shall be stopped and the OWNER and shall be immediately notified. The condition shall be corrected to the satisfaction of the OWNER, prior to resumption of Work. CONTRACTOR shall conduct personal air sampling. An independent third-party industrial hygiene consultant hired by the CONTRACTOR shall complete perimeter, work area, and final clearance air sampling. The CONTRACTOR shall stop abatement work in a asbestos regulated work area immediately when the measured airborne total fiber concentration exceeds 0.01 f/cc or the pre-abatement concentration, whichever is greater, outside the asbestos regulated work area. The CONTRACTOR shall correct the condition to the satisfaction of the CONTRACTOR'S IH and PROFESSIONAL at no cost to the OWNER. Work resumption will only be allowed upon notification by the PROFESSIONAL. CONTRACTOR shall document corrective actions.

3.3 PROTECTION OF ADJACENT WORK OR AREAS

- A. Asbestos abatement work shall be performed without contaminating adjacent work or areas. Where such work or area is damaged or contaminated as verified by the ENGINEER using visual inspection and/or sample analysis, it shall be restored to its original condition or decontaminated by the CONTRACTOR at no expense to the OWNER as deemed appropriate by the OWNER/ENGINEER. This includes inadvertent spill of dirt, dust, water, or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, work shall stop in all effected areas immediately and the spill shall be cleaned. When satisfactory visual inspection and/or sampling analysis results are obtained and have been evaluated by the CONTRACTOR'S CIH and the OWNER/ENGINEER, work may proceed.

3.4 CRITICAL BARRIERS

- A. All openings to an asbestos regulated work area shall be isolated by airtight seals to prevent contaminant spread through the building in accordance with RCSA 19a-332a-5(c). The critical barriers shall consist of 6-mil polyethylene sealed air-tight. Wall, ceiling and floor surfaces shall be covered and sealed in accordance with RCSA 19a-332a-5(e)..

3.5 ASBESTOS CONTROL AREA REQUIREMENTS

- A. General: NPEs shall be established and maintained for Class I abatement work other than glove bag removal or wrap and cut removal. A viewing inspection window shall be installed in the wall of the NPE at a location from which the abatement work may be observed. The following procedures shall be performed sequentially and each activity shall be completed before proceeding to the next.

1. The asbestos abatement will be sequenced and performed to prevent the contamination of clean areas.
2. Tools, scaffolding, staging, etc., necessary for the work placed in the area to be isolated prior to erection of critical barriers.
3. Surfaces precleaned.
4. Installation of decontamination unit(s).
5. Critical barriers installed.
6. Local exhaust ventilation system installed as required or specified.
7. Removal of ACM.
8. Collect, contain, and filter amended water in the same manner as specified for personnel decontamination shower water as in subpart 2.2.B. of this Section.

3.6 DAILY CLEAN-UP

- A. The CONTRACTOR shall maintain a clean work area by performing on a daily basis the following housekeeping functions at the end of each shift:
 1. Loose ACM shall be prepared for disposal by packaging the waste and removing it from the work area to the load-out area.
 2. Polyethylene sheeting shall be inspected and repaired.

3.7 ASBESTOS HANDLING PROCEDURES

- A. The CONTRACTOR shall employ proper handling procedures in accordance with CFR 29 Part 1926 and CFR 40 Part 61, Subpart M and the specification requirements herein. The specific abatement techniques and items identified shall be detailed in the CONTRACTOR'S AHAP including but not limited to details of construction materials, equipment, and handling procedures.

3.8 SITE INSPECTION

- A. While performing asbestos removal work, the CONTRACTOR shall be subject to on site inspection by the OWNER/ENGINEER who may be assisted by or represented by quality assurance, safety, and industrial hygiene personnel. If the work is found to be in violation of this specification, the OWNER or designated representative will issue a stop work order to be in effect immediately and until the violation is resolved. Standby time required to resolve the violation shall be at the CONTRACTOR'S expense.

3.9 CLEAN-UP AND DISPOSAL

- A. Housekeeping: Surfaces of the asbestos regulated work area shall be kept free of accumulation of asbestos-containing debris. Meticulous attention shall be given to restricting the spread of dust and debris. HEPA filtered vacuum cleaners and wet cleaning techniques shall be used. The space shall not be blown down with compressed air and dry sweeping is prohibited. When asbestos removal is complete, all asbestos waste is removed from the asbestos regulated work area, and final clean-up is completed, the CONTRACTOR, CONTRACTOR'S IH and Professional will visually inspect all surfaces within the asbestos regulated work area for residual material or accumulated debris. The CONTRACTOR shall reclean all areas showing dust or residual materials. The CONTRACTOR'S IH shall certify in writing that the area is safe before the warning signs and boundary warning tape is removed and unrestricted entry is permitted. The OWNER shall have the option to perform monitoring to certify the areas are safe before entry is permitted.
- B. Title to Materials: Material resulting from abatement work, except as specified otherwise, shall become the property of the CONTRACTOR and shall be disposed of in accordance with applicable local, state, and Federal regulations.
- C. Collection and Disposal of Asbestos: Asbestos waste, asbestos contaminated water, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing, shall be collected and placed in sealed leak-tight, containers (e.g., double 6-mil plastic bags) sealed 6-mil double wrapped polyethylene sheeting, sealed fiberboard boxes or other approved containers, and be labeled in accordance with 29 CFR 1926.58 and 40 CFR Part 61.152 as appropriate. Waste within each container must be adequately wetted (40 CFR Part 61, Subpart M). A warning and Department of Transportation (DOT) label shall be affixed or preprinted on each container. Waste asbestos material shall be disposed of at an EPA, state, and local approved asbestos landfill. If the disposal site is located in Connecticut, written authorization for disposal shall be obtained from the Department of Environmental Protection, Bureau of Waste Management. Procedure for hauling and disposal shall comply with 40 CFR Part 61, Subpart M, state, regional, and local standards.

3.10 FINAL CLEANING AND VISUAL INSPECTION

- A. Each abated asbestos regulated work area shall be cleaned by collecting, packing, and storing all gross contamination. A final cleaning shall use HEPA vacuum and wet cleaning of all exposed surfaces and equipment in the asbestos regulated work area. Upon completion of the cleaning, the CONTRACTOR'S on-site supervisor (Competent Person) and the PROFESSIONAL (a Connecticut-licensed project monitor) shall conduct a visual pre-inspection of the cleaned area in preparation for a final inspection before final air clearance monitoring and reclean, as necessary. Upon completion of the final cleaning, the CONTRACTOR'S on-site supervisor and the PROFESSIONAL shall conduct a final visual inspection of the cleaned work area in accordance with ASTM E 1368-05 and document the results of the final cleaning and

visual inspection. If the CONTRACTOR'S on-site supervisor or the PROFESSIONAL rejects the abatement area as not meeting final cleaning requirements, the CONTRACTOR shall reclean as necessary and have follow-up inspections conducted until the abatement area meets the final cleaning requirements. Re-cleaning and follow-up reinspections shall be at the CONTRACTOR'S expense.

3.11 ENCAPSULATION

- A. Prior to removal of plastic barriers and after clean-up of gross contamination and final visual inspection, a post removal (lockdown) encapsulant shall then be spray applied to ceiling, walls, floors, and other surfaces in the removal area in accordance with RCSA 19a-332a-7(c) and 8. The abatement area shall include but not to be limited to NPEs, barriers, polyethylene sheeting that covers any furnishings, and equipment articles to be discarded, critical barriers, air locks, load out units for bag removal, and on-site constructed decontamination unit.

3.12 AIR SAMPLING

- A. Sampling and the analysis of airborne concentrations of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101, RCSA 19a-332a-12(g), and as specified herein. The CONTRACTOR'S personal air monitoring samples shall be taken for at least 25 percent of the workers in each shift or a minimum of two, whichever is greater. Results of the personal samples shall be posted at the job site within 24 hours of the sampling event and made available to the OWNER. The CONTRACTOR shall maintain a fiber concentration outside NPEs equal to or less than 0.01 f/cc or background levels (whichever is greater) during asbestos abatement activities. If fiber concentrations rise above 0.1 f/cc or background levels (whichever is greater), work shall be stopped immediately and work procedures shall be investigated to determine the cause. Work shall not restart until authorized by the OWNER/ENGINEER. The CONTRACTOR'S workers shall not be exposed to airborne fiber concentrations in excess of 0.1 f/cc as an 8-hour TWA (OSHA Permissible Exposure Limit or PEL) or 1.0 f/cc averaged over a sampling period of 30 minutes (OSHA Excursion Limit). If the PEL or Excursion Limit is exceeded inside the regulated work area, the CONTRACTOR shall stop work immediately, notify the OWNER/ENGINEER, and implement additional engineering controls and work practice controls to reduce airborne fiber levels below prescribed limits in the work area. Work shall not restart until authorized by the OWNER/ENGINEER. Air monitoring results shall be calculated at the 95 percent confidence level. The CONTRACTOR shall provide an independent testing laboratory with qualified analysts and appropriate equipment to conduct sample analyses of air samples using the methods prescribed in 29 CFR Part 1926.1101 to include NIOSH Pub No. 84-100 Method 7400. The CONTRACTOR shall use for final air clearance, NIOSH Pub No. 84-100 Method 7400 (PCM) as long as the abatement project meets the criteria specified in RCSA 19a-332a-12(g).

- B. Sampling During Asbestos Abatement Work: The CONTRACTOR'S IH shall provide personal sampling as indicated in 29 CFR Part 1926.1101 and in accordance with state and local requirements, and the CONTRACTOR'S AHAP. Work area sampling shall be conducted by the PROFESSIONAL or an independent third-party consultant (with the same qualifications as the PROFESSIONAL) hired by the CONTRACTOR. Sampling shall occur at least once every shift in accordance with RCRA 19a-332a and shall be conducted outside the clean room entrance to the regulated area, inside the clean room, outside the load-out unit exit, if used, and at the exhaust discharge point of the local exhaust system. If the sampling outside asbestos regulated area shows airborne fiber levels have exceeded background levels or 0.01 f/cc, whichever is greater, all work shall be stopped immediately. The condition causing the increase shall be corrected. Work shall not restart until authorized by the OWNER/ENGINEER. In asbestos regulated areas where the construction of a NPE is not required, after initial time weighted average (TWA) airborne fiber concentrations are established, and provided the same type of work is being performed, PCM sampling shall be conducted at the boundary of the asbestos regulated work area in such locations and at such frequency as recommended by PROFESSIONAL.
- C. Sampling After Final Clean-Up (Clearance Sampling): Prior to conducting final air clearance monitoring, the CONTRACTOR'S on-site supervisor and the PROFESSIONAL shall conduct a final visual inspection of the CONTRACTOR'S final clean-up of the abated asbestos regulated work area. Final clearance air monitoring shall not begin until acceptance of this final cleaning by the Professional. The PROFESSIONAL or an independent third-party consultant (with the same qualifications as the PROFESSIONAL) hired by the CONTRACTOR will provide area sampling of airborne fibers using aggressive air sampling techniques as defined in the Appendix A of 40 CFR Part 763, Subpart E, or as otherwise required by Federal or state requirements.
1. NIOSH Method: For PCM sampling and analysis using NIOSH Pub No. 84-100 Method 7400, the fiber concentration inside the abated asbestos regulated work area, for each airborne sample shall be less than or equal to 0.01 f/cc. If any sample result is greater than 0.01 f/cc, then abatement is incomplete and recleaning is required. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria is required.
- D. Air Clearance Failure: Should clearance sampling results fail to meet the final clean-up requirements, the CONTRACTOR shall pay all costs associated with all required recleaning, resampling and analysis until final clean-up requirements are met.

3.13 POST ABATEMENT CLEAN-UP AND REOCCUPANCY

- A. No individual shall reoccupy the work area until compliance with the reoccupancy requirements of RCRA 19a-332a-12 have been achieved.

- B. Upon receiving satisfactory clearance air sample results, the CONTRACTOR shall remove all spray glue, tape residue, etc. from all floor, wall, ceiling and other finished surfaces.

++ END OF SECTION ++

SECTION 02 82 33
LEAD-BASED PAINT ABATEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, equipment, tools, materials, and permits required to test for, remove and dispose of lead-based paint as required to complete the Work. The Work includes:
 - a. Sample collection, testing, analysis, and reporting of lead-based paint.
 - b. Removal and disposal of lead-based paint.
2. This specification details minimum acceptable requirements for demolition activities affecting materials and structures coated with lead-based paint. All environmental work under this CONTRACT shall be performed using methods demonstrated to prevent lead emissions outside the lead control area when used in accordance with manufacturer's recommendations. CONTRACT work shall be performed to minimize the creation of airborne dust and vapors; minimize the quantity of hazardous waste generated; protect the health and welfare of all site personnel and the public; and, avoid adverse environmental impacts.

B. Related Sections:

1. Section 02 41 00, Demolition.
2. Section 02 82 32, Asbestos Abatement.
3. Section 09 91 00, Painting.

C. Lead Paint Locations:

1. For known lead-based paint locations, and information on previous testing, CONTRACTOR shall reference Supplementary Conditions.
2. For locations not previously sampled or inaccessible during the previous survey and sampling, CONTRACTOR shall perform sampling on all painted structure, equipment, piping, walls, floors, ceilings and Work affected by the scope of this project, prior to the demolition, alteration and removal of materials.
3. Sample collection, testing, analysis and reporting shall be performed by a laboratory certified by the State of Connecticut for lead testing.
4. Locations where lead-based paint have been determined to exist shall be marked and identified in the field. Each location shall be marked with orange safety paint.
5. The limits of demolition are shown on the drawings.

1.2 REFERENCES

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
1. ANSI Z88.2 - 1980 Respiratory Protection.
 2. 29 CFR 1910 - Occupational Safety and Health Standards.
 3. 29 CFR 1926 - Safety and Health Regulations for Construction.
 4. 40 CFR 50 - National Primary & Secondary Ambient Air Quality Standards.
 5. 40 CFR 60 - Standards of Performance for New Stationary Sources.
 6. 40 CFR 117 - Determination of Reportable Quantities of Hazardous Substances.
 7. 40 CFR 171 - Standards for Transportation of Hazardous Materials.
 8. 40 CFR 172 - Hazardous Materials Tables and Hazardous Materials Communications Regulations.
 9. 40 CFR 173 - General Requirements for Shipments and Packaging.
 10. 40 CFR 178 - Shipping Container Specifications.
 11. 40 CFR 260 - Hazardous Wastes Management Systems General.
 12. 40 CFR 261 - Identification and Listing of Hazardous Waste.
 13. 40 CFR 262 - Generators of Hazardous Wastes.
 14. 40 CFR 263 - Transporters of Hazardous Wastes.
 15. 40 CFR 264/265 - Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.
 16. 40 CFR 268 - Land Disposal Restrictions.
 17. 40 CFR 302 - Designation, Reportable Quantities and Notification.
 18. 40 CFR 745-225 - U.S. Department of Health and Human Services National Institute for Occupational Safety & Health (NIOSH).
 19. 40 CFR 745 -Lead; Identification of Dangerous Levels of Lead
 20. EPA Method 7082 - Test Methods for Evaluating Solid Wastes.
 21. EPA SW-846 - Test Methods for Evaluating Soil Waste Physical/Chemical Methods.
 22. EPA Method 3050 Acid Digestion of Sediments, Sludge, and Soils.
 23. UL 586 - 1990 High-Efficiency, Particulate, Air Filter Units.
 24. NIBS, Guideline Specifications for Reducing Lead-Based Paint Hazards.
 25. ASTM D3335 - Test Method for Low Concentration for Lead, Cadmium and Cobalt in Paint by Atomic Absorption Spectroscopy; Compilation of ASTM Standard Guides, Test Methods and Practices on Lead-Based Paint Abatement.
 26. SSPC GUIDE 6 (CON) - Guide for Containing Debris Generated During Lead Removal Operations.
 27. SSPC GUIDE 7 (DIS) - Guide for the Disposal of Lead-Contaminated Surface Preparation Debris.
 28. SSPC SP-11 - Surface Preparation Specification Power Tool Cleaning to Bare Metal.

1.3 DEFINITIONS

- A. Abatement: Abatement of lead-containing paint involves demolition of materials and structures coated with lead-containing paint and removal of lead-based paint from structures and materials.
- B. Action Level: The Occupational Safety and Health Act (OSHA) Construction Standard 29 CFR 1926.62 defines the action level as the employee exposure, without regard to use of respirators, to airborne concentrations of lead equal to or above 30 micrograms per cubic meter of air (30 µg/m³), 8-hour time-weighted average.
- C. Amended Water: Water containing at least one ounce of five percent (5%) trisodium phosphate per gallon of water.
- D. Area Monitoring: Air sampling to determine lead concentrations within and outside the lead control area for the purpose of determining compliance with the Action Level.
- E. Atomic Absorption Spectroscopy: An analytical method of determining the lead content of a given sample.
- F. Physical Boundary: Area physically roped or partitioned off around a lead control area to limit unauthorized entry of personnel. As used in this section, "outside boundary" shall mean the same as "outside lead control area."
- G. Certified Industrial Hygienist (CIH): As used in this Section, refers to an Industrial Hygienist employed by CONTRACTOR and certified by the American Board of Industrial Hygiene (ABIH) in comprehensive practice.
- H. Change Rooms: Rooms within the designated physical boundary around the lead control area set up to prevent cross-contamination and equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes.
- I. Competent Person: Means one who is capable of identifying existing and predictable lead hazards in the surroundings or working conditions and who has authorization to take prompt corrective action to eliminate such hazards.
- J. Decontamination Area: Area for removal of contaminated personal protective equipment (PPE).
- K. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.

- L. High Efficiency Particulate Air (HEPA) Filter Equipment: Vacuuming equipment containing a UL 586 HEPA filter system capable of preventing passage of lead contaminated paint dust with an efficiency of 99.97 percent of all particulates greater than 0.3 micron size.
- M. Inductively Coupled Plasma Atomic Emission Spectrometry: An analytical laboratory method of determining the lead content of a given sample.
- N. Industrial Hygiene Technician: A person trained and experienced in the use of environmental sampling equipment as applicable to this Project and who is under the direct supervision of the CIH.
- O. Lead - Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.
- P. Lead Control Area: An emission control area to prevent the spread of lead dust, paint chips or debris from projects disturbing lead-containing paint or materials. The lead control area is isolated by physical boundaries to warn unauthorized personnel against entry.
- Q. Lead-based Paint: Paint is considered to be lead-based when it contains detectable quantity of lead to the limit of detection using EPA Method SW 846 Method 6010.
- R. Lead-Containing Material: Any component, paint or surface coating material containing detectable concentrations of lead by weight in the dry solid (16 CFR 1303).
- S. Lead Waste: Miscellaneous waste, dust or debris generated during removal of lead-containing materials, cleanup of a lead control area, or decontamination activities.
- T. Permissible Exposure Limit (PEL): 50 micrograms per cubic meter of air as an 8-hour TWA as determined by OSHA 29 CFR 1926.62. If an employee is exposed for more than 8 hours in a workday, the allowable exposure limit shall be calculated by the following formula:
allowable exposure limit = 400 micrograms per cubic meter of air/hours worked per day.
- U. Personal Monitoring: Personal air sampling, performed within the breathing zone of an employee, by the independent CIH or by a qualified technician under direct supervision at the independent CIH to determine the 8-hour time weighted average concentration in accordance with NIOSH Method 7600. Samples shall be taken on individuals who are representative of each of CONTRACTOR'S job categories.
- V. Wipe Sampling: Testing procedures to confirm the effectiveness of controls to prevent the release of lead-containing dust outside the lead control area. Whatman filters moistened with deionized water shall be used to sample a 1-square foot area.

- W. Trigger Activities: Activities that involve the disturbance of lead-containing materials will trigger requirements under the OSHA Lead In Construction standard for conducting personnel exposure assessment sampling, training, medical monitoring, respiratory protection and other requirements as specified in 29 CFR 1926.62. Examples of trigger activities include abrasive blasting, welding, cutting, torch burning, manual demolition of structures, manual scraping, manual sanding, heat gun application, rivet busting, and power tool cleaning.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. CONTRACTOR shall have on staff and assigned to this Project a Lead Paint Abatement Supervisor accredited in the State of Connecticut who will supervise all lead paint activities, and who is a Competent Person, as defined in 29 CFR 1926(b), with a minimum of 2 years experience in lead abatement project work, at least 5 years experience in construction trades, and who has served as a Competent Person on at least three lead projects of comparable scope and methodology to this project. This shall be documented by providing the name of the Competent Person and proof of training to the OWNER.
2. As applicable for lead removal work, CONTRACTOR/Subcontractor must have a Lead Contractors license in the State of Connecticut and shall have successfully completed at least two abatement projects of comparable scope to this Project within the past 3 years, utilizing the same methods to be employed on this project. This shall be documented by identifying the owner of the facility (including name, address and phone number of owner/project manager), type of facility, volume of material abated, specific tools/technology employed, method of abatement, name of CONTRACTOR and Competent Person supervising work.

B. Regulatory Requirements:

1. In addition to the detailed requirements of this Specification, CONTRACTOR shall comply with all applicable laws, ordinances, rules, and regulations of federal, state, and local authorities pertaining to removal, handling, storage, transportation, and disposal of lead waste materials. CONTRACTOR shall also comply with the applicable requirements of 29 CFR 1926.62. All matters regarding interpretation of standards shall be submitted in writing to the OWNER for resolution before starting work. Where specifications, requirements, and the referenced documents vary, the most stringent requirement shall apply.
2. Appropriate Waste Containers: Containers for the storage of all waste shall be DOT-approved and shall be provided by CONTRACTOR.

1.5 SUBMITTALS

A. CONTRACTOR shall submit the following:

1. Testing Laboratory Qualifications for Air Samples: Submit the name, address, and telephone number of the testing laboratory selected to perform the analyses of all air monitoring. The testing laboratory shall be accredited by the American Industrial Hygiene Association (AIHA) and be accredited by the Environmental Lead Laboratory Accreditation Program (ELAPP). Provide AIHA and ELAPP documentation along with date of accreditation/reaccreditation.
2. Independent CIH: Submit the name of the Independent CIH selected to conduct personnel and area/environmental air sampling, and document evidence that the Independent CIH is currently certified in comprehensive practice by the American Board of Industrial Hygiene, including certification number and date. CONTRACTOR shall submit certification that the Independent CIH is in no way affiliated with CONTRACTOR. A qualified technician under direct supervision of the Independent CIH may perform Independent CIH tasks specified herein. The Independent CIH shall include a list of tasks to be performed by the technician under the supervision of the Independent CIH and the name and qualifications of technician. The use of an Independent CIH and technician shall not relieve CONTRACTOR of responsibility for ensuring a safe working environment for lead paint removal.
3. Lead Control Plan: 30 Days prior to commencing and lead abatement activities, CONTRACTOR shall submit a detailed job-specific plan of work procedures to be used during activities affecting lead-containing paint and materials. The plan shall be submitted to the Engineer for review. The plan shall include a sketch showing the details of the lead control area, location and details of decontamination rooms including showers (if required), change rooms, eating, drinking, smoking, and restroom areas. The plan shall include interface of trades, sequencing of lead-related work, collected wastewater and paint debris disposal plan, air sampling plan, proposed respirators, protective equipment, and a detailed description of the method of emissions control which will be used to ensure that airborne lead concentrations of 30 µg/m³ of air are not exceeded outside the lead control area. The plan shall be prepared in accordance with 29 CFR 1926.62 and signed by a CIH meeting the qualifications set forth above. The Competent Person shall be responsible for oversight of the plan during construction.
Additionally, the Plan shall include:
 - a. A description of each activity in which lead is emitted; e.g. equipment used, material involved, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices.
 - b. A description of the specific means that will be employed to achieve compliance and, where controls are required, plans and studies used to determine methods selected for controlling exposure to lead.
 - c. A report of the technology considered in meeting the PEL.
 - d. A detailed schedule for implementation of the program.
 - e. A work practice program which includes a protective work clothing plan, a housekeeping plan, and a hygienic facilities and practices plan.

- f. An administrative control schedule, as applicable.
 - g. The schedule for a compliance-monitoring program to be made by the Independent CIH.
 - 4. Rental equipment notification as defined in paragraph 2.1 of this Section.
 - 5. Hazardous Waste Management Plan shall be submitted to the Engineer for review; the plan shall be defined and detailed hereinafter.
 - 6. Chemical Analysis and Material Safety Data Sheets: Provide Chemical Analysis and Material Safety Data Sheets for all chemical stripping products to be used in the work. Show by copy of transmittal form that a copy of each MSDS has been transmitted to CONTRACTOR'S Competent Person.
 - 7. Equipment List: Identify the equipment that will be used to control, remove, collect and containerize the lead and lead wastes generated during demolition activities, and the procedures that will be followed to clean the lead control area. Shop Drawings and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300, Submittals.
 - 8. Training: For all activities that result in airborne lead concentration equal to, or in excess of the Lead Action Level, or for those activities that take place within a Lead Control Area, CONTRACTOR shall submit for this Contract a sufficient number of properly trained and experienced lead-trained workers each of whom shall (a) be licensed in the State of Connecticut, (b) have completed training as a lead worker as per 29 CFR 1926.62 subpart (I); (c) have completed respirator training per 29 CFR 1910.134; (d) have completed initial medical monitoring and have blood lead levels below 35 micrograms per deciliter ($\mu\text{g}/\text{dl}$): if the worker's blood lead level (BLL) is in excess of 35 $\mu\text{g}/\text{dl}$, the worker shall show medical approval for this work.
 - 9. Documentation: Documentation for each employee (as required per federal and State of Connecticut regulations) shall be provided to the OWNER including: (a) dates and proof of licensing in the State of Connecticut, (b) dates and proof of lead training; (c) dates and proof of respirator training and fit testing; (d) dates and proof of initial medical surveillance by CONTRACTOR or other employer in the past year and participation in present employer's ongoing medical surveillance; (e) proof of BLL prior to assignment under 35 $\mu\text{g}/\text{dl}$ (if the worker's BLL is in excess of 35 $\mu\text{g}/\text{dl}$, the worker shall show medical approval for this work).
 - 10. CONTRACTOR shall submit a signed notarized statement disclosing all OSHA and EPA citations on lead projects in the past 3 years.
- B. Field Test Reports and Records: During all lead removal operations under this Contract, CONTRACTOR shall maintain and provide the following documentation:
- 1. All air monitoring results, area clearance surface wipe results, and daily reports shall be provided to the ENGINEER within 3 working days of the date the samples are taken, signed by the testing technician performing the air monitoring and surface sampling and the employee that analyzed the sample. All laboratory results shall be accompanied by complete chain-of-custody documentation.

- C. Hazardous Waste Disposal Documentation: Completed hazardous waste manifests signed by the treatment or disposal facility shall be provided to the OWNER within 10 days of Contractor's receipt.
- D. Hazard Communication Program: CONTRACTOR shall submit proof of the establishment and implementation of a Hazard Communication Program as required by 29 CFR 1910.1200.
- E. Hazardous Waste Management Plan: The Hazardous Waste Management Plan shall comply with applicable requirements of federal, state, and local hazardous waste regulations and address:
 - 1. Identification of hazardous wastes associated with the work as defined in 40 CFR 261.
 - 2. Estimated quantities of wastes to be generated and disposed of.
 - 3. Names and qualifications of each vendor that will be transporting, storing, testing, and disposing of the wastes. Include the disposal facility location and a 24-hour phone contact. Furnish copies of EPA identification numbers prior to start of operations.
 - 4. Names and qualifications (experience and training) of personnel who will be responsible for on-site management of hazardous wastes prior to start of operations.
 - 5. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
 - 6. Spill prevention, containment, and cleanup contingency measures to be implemented.
 - 7. Details of on-site hazardous waste storage, removal, and disposal. Hazardous wastes shall be collected and containerized daily. CONTRACTOR shall inspect storage areas weekly, and the inspections documented.
- F. Non-Hazardous Waste Disposal Documentation: Mechanical equipment coated with lead-based paint shall be recycled as scrap metal. Segregate scrap metal from other construction and demolition debris. Provide weight ticket from the scrap metal recycler within 10 days of recycling.
- G. Shop Drawings: Submit the following:
 - 1. Copies of manufacturer's specifications and instructions for each manufactured product.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General Equipment:

1. Respirators: Select respirators approved by the National Institute for Occupational Safety and Health (NIOSH) for use in areas containing lead-contaminated dust and fumes. Provide personnel within the lead control area with adequate and appropriate respiratory protection until the Competent Person establishes the workplace exposure concentration for the specific operation. Once the concentration has been determined, CONTRACTOR may modify respiratory protection as outlined in 29 CFR 1926.62 and the Lead Control Plan.
2. Special Protective Clothing: Furnish personnel who have a potential to be exposed to lead-contaminated dust or fumes with appropriate disposable protective whole body clothing, head covering, gloves, and foot coverings. Tape sleeves at the wrist and secure foot coverings at the ankles. Furnish appropriate disposable plastic or rubber gloves to protect hands. Ear muffs or other protection shall be provided and used during all removal operations with power tools unless it is demonstrated that noise levels are within OSHA/NIOSH standards. Eye protection shall be worn and used throughout operations involving clean up and removal of lead-containing material. The level of protection may be adjusted upon completion of initial employee exposure assessment with approval of CIH, but must be maintained at levels not less than those stated in this paragraph.
3. Rental Equipment Notification: If rental equipment is to be used during lead-containing paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. All data demonstrating compliance with the performance requirements of Article 1.4 must be presented to and approved by the ENGINEER prior to use.
4. Filter Certifications: HEPA Filters used in filtered vacuuming equipment must meet or exceed UL 586 requirements and cutting tools manufacturer's specifications and recommendations.

B. Lead Paint Removal Equipment:

1. CONTRACTOR may only use products and tools meeting the performance specifications outlined below:
 - a. CONTRACTOR shall utilize a vacuum assisted power tool system with demonstrated suitability and efficiency in preparing metal surfaces to the SSPC SP-11 standard and with demonstrated effectiveness in maintaining lead emissions below 30 µg/m³ during abatement operations. Such systems may include dustless needle guns, dustless automatically recirculating wheel blast (rotopeens), and right angle grinders which capture all dust and debris at the cutting tool edge and transport the material under vacuum conditions to an air tight disposal container. Dustless needle guns shall be utilized on metal surfaces only.
 - b. The system shall be designed so as to permit the removal and replacement of collection containers under negative pressure so as to prevent the release of dust during removal and replacement operations and shall be equipped with an automatic shut off in the event of vacuum failure.

- c. Recovery/abrasive action tool shall be monitored at all times by a device capable of determining recovery at the face of each tool and automatically disabling the tool in the event recovery levels are insufficient. The monitor, as a minimum, shall have the following features: remote warning light, adjustable recovery set point, automatic equipment disabling capabilities, sensing range of 0-5 psi, solid-state photohelic instrumentation, and remote sensing at the tool face. The safe recovery point shall be calibrated each day before start up, or each time a new tool or vacuum source is used. All of the manufacturer's recommendations shall be followed with respect to set-up and use of the monitor. A daily log shall be maintained and available for inspection by the ENGINEER identifying all calibrations of recovery levels and down time as a result of insufficient recovery levels. Manufacturer's operations manual shall be on site at all times.
- d. The system may not use any products containing crystalline silica, nor introduce any non-recoverable materials, nor utilize any cutting material that introduces toxic or hazardous materials.
- e. The cutting head for use on flat surfaces must be capable of cutting to within 1-1/2 inch of any inside corner, molding or edge and may include rotopeen scalers, and dustless needle guns. Tools for corners and moldings must be specifically designed for that purpose and conform to all inside corners, outside corners, curved, flat and angled surfaces to be abated under this Contract while maintaining vacuum control at the work surface/cutting head interface. Shrouded HEPA vacuum fitted needle guns may be used for non-flat surfaces in accordance with manufacturer recommendations. Vacuum assisted finishing tools such as right angle grinders may be used to achieve the SSPC SP-11 standard but may not be used for primary removal.

PART 3 – EXECUTION

3.1 GENERAL

- A. Commencement of Work: Five days prior to the proposed start of work at each separate location, CONTRACTOR shall notify the ENGINEER in writing. No work may proceed at each location until authorized by the ENGINEER.
- B. CONTRACTOR shall submit any required equipment shutdown plans to the ENGINEER 14 days prior to starting the work.
- C. CONTRACTOR shall inform the ENGINEER in writing of proposed access restrictions to other personnel (i.e., areas or items of equipment which will not be accessible during the proposed lead work), giving the estimated time frames and dates of such proposed access restrictions.

- D. In the event that ENGINEER personnel must enter the lead control area for reasons unrelated to the supervision or inspection of work under this Contract (under emergency conditions), CONTRACTOR shall stop work and immediately clean-up any loose debris, so as to permit safe entry by ENGINEER personnel. Abatement work shall not proceed until ENGINEER personnel have left the control area.

3.2 PROCESS AND PROCEDURES

- A. Protection of Existing Work to Remain: All lead removal work must be conducted without damage to, or contamination of adjacent areas, equipment or surfaces within the Lead Control Area or contamination of existing work or previously cleaned surfaces. CONTRACTOR shall correct all such damage or contamination immediately at CONTRACTOR'S expense.
- B. Decontamination: Provide a "decontamination area" within the physical boundary around the designated lead control area. The decontamination area shall include washing facilities for personnel use prior to eating, drinking, or smoking.
- C. Hygiene Facilities and Practices: CONTRACTOR shall provide clean change areas for employees engaged in lead work. The change areas shall be equipped with separate storage facilities for protective work clothing and equipment and for street clothes to prevent cross-contamination.
 - 1. CONTRACTOR shall assure that employees do not leave the immediate work area wearing any protective clothing or equipment that is required to be worn during the work shift.
 - 2. Eating, smoking, drinking, chewing tobacco, and chewing gum are not allowed in the lead control area.
- D. Showers. CONTRACTOR shall provide shower facilities for use by employees whose airborne exposure to lead is above the PEL. When shower facilities are necessary, employees are required to shower at the end of the work shift and CONTRACTOR is required to provide an adequate supply of cleansing agents and towels for use by affected employees.
- E. Warning Signs and Labels: Provide conspicuous warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.
 - 1. The warning signs shall be posted at each control area and at all approaches to the control area so that employees and/or public may read signs before entry and take necessary protective action.
- F. Air Monitoring: Monitoring of airborne concentrations of lead and other toxic metals, as applicable, shall be in accordance with 29 CFR 1926.62 and as specified herein. A CIH or an industrial hygienist (IH) technician working under

the direct supervision of the Independent CIH shall perform air monitoring, testing, and reporting.

1. Obtain personal air monitoring samples from employees who are anticipated to have the greater risk of exposure as determined by the CIH or Competent Person. In addition, obtain a minimum of two air-monitoring samples outside the lead control area on a daily basis for the duration of the lead work.
 2. Obtain final air monitoring samples when the lead abatement work is complete. The CIH should perform final air sampling before the area is turned back over to OWNER. The results must be less than the action level of 30 $\mu\text{g}/\text{m}^3$. Should any of the final samples indicate a higher value, CONTRACTOR shall take appropriate actions to re-clean the area and shall repeat the sampling and analysis at CONTRACTOR'S expense.
 3. Submit results of air monitoring samples to the ENGINEER within 3 days after the air samples are taken, at or within 24 hours from receipt of analytical results, which are in excess of the action level of 30 $\mu\text{g}/\text{m}^3$.
- G. Monitoring Employees: Personal air monitoring shall be carried out during every work shift on at least one employee for each task for the entire shift. Complete documentation on the shift, date, employee hours, hours of abatement work, hours of monitoring and task performed should be provided with each sample and shall accompany the laboratory transmission and be returned by the laboratory with results. The task performed shall be fully described on the sample submission. If the area air monitoring indicates an emission level in excess of 30 $\mu\text{g}/\text{m}^3$ of air outside the lead control area, lead work shall be stopped. CONTRACTOR shall take immediate corrective action to reduce area emission levels below 30 $\mu\text{g}/\text{m}^3$ of air, and CONTRACTOR shall clean adjacent areas at no cost to OWNER.
- H. After Final Clean-Up (Clearance Examination): Perform a clearance examination (i.e., visual evaluation and sampling) to determine if levels of lead above EPA standards remain following cleaning. After final clean up of the abatement area has been performed, the CIH (or qualified IH technician under the supervision of the CIH) shall perform a visual evaluation to insure that the control and work area is free of accumulations of dirt, dust or debris. In addition, the examination will include surface wipe sampling to verify that remaining lead levels are below EPA lead hazard standards prior to turning the site over to OWNER. Should any of the final samples indicate a higher value than EPA standards, CONTRACTOR shall take appropriate actions to re-clean the area and shall repeat the sampling and analysis at CONTRACTOR'S expense.

3.3 CLEANUP AND DISPOSAL

- A. Cleanup: Maintain all surfaces, including protective tarps and coverings within the lead control area, free of accumulations of paint chips, dust and debris. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to cleanup the area. Perform housekeeping at the end of each shift, and when paint removal operations have

been completed, by cleaning the lead control area of visible paint chips using a HEPA-filtered vacuum.

- B. Testing of Lead Waste: Test lead waste in accordance with 40 CFR 261 for hazardous waste. Submit a minimum of four randomly collected samples to a certified ELAPP laboratory to determine if it is hazardous waste. Test all samples for the eight toxicity characteristic leaching procedure (TCLP) metals.
- C. Collection of Debris: Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing, separating waste by type (i.e., contaminated clothing, used containers, drop cloths, and surface materials should be separated).
 - 1. Do not fill any container or roll-off in excess of the capacity marked on the container. Cover all containers immediately after filling.
 - 2. Store removed lead waste, lead-contaminated clothing and equipment, dust, and debris in U.S. Department of Transportation (DOT)-approved container systems. Label each container to identify the waste and the date wastes were first put into the container and ensure that labels remain intact and legible. Labels/markings shall meet the requirements of 40 CFR 262.34.
 - 3. No water mixed with or contaminated by hazardous or toxic debris may be released into any drain or sewer. CONTRACTOR is advised that discharge of more than 10 pounds of lead into the water within a 24-hour period shall be considered a violation of the Clean Water Act and treated as a reportable quantity in accordance with 40 CFR 117. Such release shall be grounds for immediate termination of this Contract and CONTRACTOR shall be liable for any fines, penalties or remediation costs.
 - 4. Disposal shall be at a site included in the approved Hazardous Waste Management Plan. Notify the ENGINEER at least 14 days prior to removal of the containers to inspect the containers and the hazardous waste manifest. As necessary, dispose of lead wastes to ensure containers do not remain on the job site longer than 90 calendar days from the initial loading date affixed to the container.
 - 5. Handle, label, store, transport, and dispose of lead or lead-contaminated waste in accordance with 40 CFR 261, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
- D. Non-hazardous Waste: Store non-hazardous waste separate from hazardous wastes. Provide all necessary containers, transportation, and disposal in accordance with federal, state and local regulations.
- E. Disposal Documentation: Submit written evidence that the receiving lead waste treatment, storage, or disposal facility (TSD) is approved to accept lead waste by the federal and district or local regulatory agencies. Submit completed waste manifests in accordance with Section 1.5.C of this specification.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 02085

NON-LIQUID PCB MATERIAL REMOVAL

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The CONTRACTOR shall provide all plans and approvals, notifications and permits, labor, materials, services, equipment, tools, and incidentals as appropriate to remove, collect, transport, and dispose of PCB bulk product waste as required for deconstruction and demolition, including removal and disposal of existing pumps and piping.
 - 1. If asbestos and/or lead-based paint containing materials are also present, PCB abatement workers shall also have asbestos and/or lead paint certification/training as specified in Sections 02 82 33, Lead-Based Paint Abatement and 02 82 32, Asbestos Abatement.
- B. All PCB removal waste material generated during this Work shall be managed as required by Regulations. Any waste material containing or contaminated by PCBs in concentrations greater than or equal to ($\geq$) fifty (50) parts per million (ppm) is a TSCA waste regulated by the United States Environmental Protection Agency (USEPA). Any waste material containing or contaminated by PCBs $\geq$ one (1) ppm but less than ($<$) fifty (50) ppm are regulated by the State of Connecticut Department of Energy and Environmental Protection (CTDEEP).
- C. The removal and disposal of PCB contaminated building materials is regulated under the Regulations of Connecticut State Agencies (RCSA) 22a-463 through 22a-469 for PCB concentrations > 1 ppm. PCB concentrations detected at the site range from less than ($<$) 1 ppm to 2.1 ppm.
- D. This Section details minimum acceptable requirements for demolition/removal of PCB containing materials, equipment, piping, anchorages, appurtenances, caulk, concrete, brick, etc. All work shall be performed using methods demonstrated to prevent PCB contamination outside the PCB Control Area. The following materials are addressed herein and may be referred to as PCB Material:
 - 1. PCB bulk product waste, as governed by 40 CFR 761.62;
 - 2. PCB material containing greater than or equal to one (1) ppm but less than fifty (50) ppm PCBs (Governed under Connecticut General Statutes 22a-463 through 469);
 - 3. Personal Protective Equipment (PPE) used in PCB abatement and decontamination remediation waste, as governed under 40 CFR 761.61.
- E. PCB Material Locations
 - 1. For known PCB Material locations, and information on previous testing, CONTRACTOR shall reference Supplementary Conditions. The CONTRACTOR shall use the sampling and analysis report as a guide but shall not hold the OWNER liable for potential omissions and errors.

2. For locations not previously sampled or inaccessible during the previous survey and sampling, CONTRACTOR shall perform sampling on all painted structure, equipment, piping, walls, floors, ceilings and Work affected by the scope of this project, prior to the demolition, alternation and removal of materials.
 3. Unless determined by CONTRACTOR through testing, all suspect materials shall be treated as PCB-containing paint/coatings and caulk and abated in accordance with the specification requirements.
 4. Locations where PCB-containing paint/caulk has been determined to exist shall be marked and identified in the field by the CONTRACTOR. Each location shall be marked with brightly colored marking paint and include the PCB concentration along with its Lead concentration, where applicable.
 5. PCB sample testing, analysis and reporting shall be performed by a laboratory certified by the State of Connecticut, using soxhlet extraction (USEPA Method 8082).
- F. Coordination and Compliance:
1. Comply with Section 01 14 16, Coordination with Owner's Operations and Section 02 41 00, Demolition.
 2. Implement procedures under this and other Sections and coordinate the Work that must be performed with or before demolition and removals.
 3. CONTRACTOR shall assume full responsibility and liability for compliance with all applicable Federal, State and local laws, rules and regulations pertaining to work practices, protection of Workers, authorized visitors to the site, persons, and property adjacent to the Work.
- G. Scheduling:
1. Notify the ENGINEER 20 days prior to the start of any non-liquid PCB removal activities.

1.2 DEFINITIONS

- A. Abatement: Removal of PCB containing paint and PCB impacted material (e.g., piping and equipment) that involves demolition and/or remediation of materials and structures containing PCBs.
- B. Certified Industrial Hygienist (CIH): Refers to an industrial hygienist certified by the American Board of Industrial Hygiene (ABIH) in comprehensive practice.
- C. Competent Person: Means one who is capable of identifying existing and predictable PCBs, asbestos and/or lead hazards in the surroundings or working conditions and who has authority to take prompt corrective action to eliminate such hazards.
- D. Connecticut Regulated PCBs: Material originally containing or contaminated by PCBs in concentrations at or above one (1) ppm but less than fifty (50) ppm. These include, but are not limited to, PCB oils, caulk, paint, and equipment.
- E. Contractor Work Plan: A Contractor Work Plan must be prepared prior to commencing any actions where USEPA and/or CTDEEP approval is required due to the remedial nature of the work. The self-implementing procedures for removal or

abatement of PCB contaminated building materials require that a Contractor Work Plan be prepared [40 CFR 761.61(a)] and submitted to USEPA as part of the notification and certification requirements. The plan must include a description of the removal and abatement schedule, disposal technology, and approach. The cleanup approach described in the plan shall identify the proposed cleanup levels, removal and abatement procedures, verification sampling procedures, waste storage and handling procedures, and disposal options. The plan also must contain options and contingencies to be used if unanticipated higher concentrations or wider distribution of PCB contamination occurs. Contractor shall be responsible for providing Owner and Engineer with all documentation required by the USEPA approved PCB Abatement Work Plan.

- F. NACE 2 Near White Blast Cleaning Requirements: A near-white metal blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter. Random staining shall be limited to no more than five percent (5%) of each unit area of surface, and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating.
- G. NACE 3 Commercial Blast Cleaning Requirements: When viewed without magnification, the surface shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter of at least 66 2/3% (66.66%) of unit area. Light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating in less than 33 1/3% (33.33%) of the unit area is acceptable.
- H. PCB Bulk Product Waste: Waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was PCBs $\geq$ 50 mg/kg. PCB bulk product waste includes, but is not limited to:
 - 1. Non-liquid bulk wastes or debris from the demolition of buildings and other man-made structures manufactured, coated, or serviced with PCBs. PCB bulk product waste does not include debris from the demolition of buildings or other man-made structures that is contaminated by spills from regulated PCBs which have not been disposed of, decontaminated, or otherwise cleaned up in accordance with TSCA requirements.
 - 2. Examples also include: plastics (such as plastic insulation from wire or cable; radio, television and computer casings; vehicle parts; or furniture laminates); pre-formed or molded rubber parts and components; applied dried paints, varnishes, waxes or other similar coatings or sealants; caulking; adhesives; paper; Galbestos; sound deadening or other types of insulation; and felt or fabric products such as gaskets; and fluorescent light ballasts containing PCBs in the potting material.
- I. PCBs: PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. They have a range of toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to

their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications.

- J. PCB Control Area: An area established outside the PCB Regulated/Containment Area designated such that the spread of dust from paint, caulk, concrete, etc. containing PCBs is prevented. The control area is isolated by physical boundaries to warn unauthorized personnel against entry.
- K. PCB Impacted Materials: PCBs are known to contaminate adjacent building material (e.g., masonry, wood, concrete) surrounding a PCB source. Therefore, any surrounding building material that is contaminated by a source of PCBs that is greater than fifty (50) ppm, such as through leaching of PCBs is considered PCB bulk product waste provided the PCB bulk product waste, such as caulk or paint, has not been removed from the building material. Disposal of the PCB bulk product waste must be completed in accordance with 40 CFR 761.62. If the PCB source is less than fifty (50) ppm and the adjacent material contains PCBs greater than or equal to one (1) ppm, the CTDEEP requires the material to be properly removed and disposed of in conformance with CGS 22a-463 through 469.
- L. PCB Item: Any PCB article, PCB article container, PCB container, or PCB equipment that deliberately or unintentionally contains, or has as a part of it, any PCBs.
- M. PCB Regulated/Containment Area: The area where PCB remediation work is taking place.

1.3 SUBMITTALS

- A. The CONTRACTOR shall prepare a Demolition and Removal Plan in accordance with Section 02 41 00, Demolition, which includes procedures for the removal and disposal of the PCB material. The procedures proposed in the Plan shall be in accordance with 40 CFR 761, CGS 22a-463 through 469.
- B. The CONTRACTOR shall prepare a PCB Health and Safety Plan (PCB HASP) in accordance with the OSHA requirements. The PCB HASP is required for all PCB abatement and removal activities and areas. PCB abatement and removal work cannot begin until the OWNER has accepted the PCB HASP in writing.
 - 1. The PCB HASP shall be prepared by the abatement Contractor's Competent Person, or a Certified Industrial Hygienist (CIH).
 - 2. The PCB HASP shall include, but not be limited to:
 - a. Detailed personal air monitoring plan.
 - b. Personal protective equipment to be used.
 - c. Location of the PCB Regulated Containment and PCB Control Areas, including clean and dirty areas, decontamination unit (clean room, shower room, equipment room, storage areas such as load-out unit).

- d. Abatement methods and anticipated airborne concentrations for each type of abatement method.
- e. Interface of trades involved in site construction activities.
- f. Sequencing of the abatement/removal work.
- g. Disposal activities.
- h. Fire and medical emergency response procedures, and the specific security procedures to be used for all regulated work areas.
- i. Some items that contain PCBs may also contain lead or asbestos. The PCB HASP must also acknowledge and address these hazards when present.
- j. Qualifications: A written qualifications and organization section providing evidence of qualifications of the CONTRACTOR, the CONTRACTOR's on-site Project Supervisor (Competent Person), CONTRACTOR workers, all Subcontractor's, Subcontractor supervisors, Subcontractor workers, and independent testing laboratory for air and wipe sampling analysis. The qualification section shall contain information required below:
 - 1) Evidence that the CONTRACTOR's full-time, on-site Project Supervisor is designated as, and is qualified to be a "Competent Person" in accordance with 29 CFR Part 1910/1926 and is experienced in the administration and supervision of lead, asbestos, and PCB abatement projects, including work practices, abatement methods, protective measures for personnel, inspection of abatement work areas, PCB generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements.
 - i. The designated "Competent Person" on-site Project Supervisor shall be responsible for compliance with applicable Federal, state and local requirements, and have a minimum of two (2) years of on-the-job asbestos, lead paint, and PCB abatement supervisory experience, and be licensed by the State of Connecticut as a lead abatement and asbestos abatement supervisor.
 - ii. If the Competent Person is not on Site at any time whatsoever, all PCB Work shall be stopped. The Competent Person shall remain on site until the PCB Work is complete. The Competent Person cannot be removed from the Project without the written consent of the OWNER and the ENGINEER. The Competent Person shall be removed from the PCB Work if so requested by the OWNER.
 - 2) Evidence that the laboratory performing bulk sample and air sample analysis and reporting is certified by the State of Connecticut.
 - 3) The name, contact person(s), address and telephone number of each independent third-party testing subcontractor selected to perform the sample collection and/or analyses and report the results of the CONTRACTOR's personal air samples. The testing laboratory shall also be completely independent from the CONTRACTOR as recognized by Federal, state or local regulations.
 - 4) Employee Training and Certification of Worker Acknowledgement. The following training documentation for each employee of the CONTRACTOR and/or abatement subcontractor to be engaged in the abatement work who will be potentially exposed to PCBs as determined

by their direct handling of the material, entrance into a regulated work area, or airborne exposure in excess of 0.5 mg/m³ PCBs measured as an 8-hour time-weighted average (TWA):

- i. Copy of certification of accreditation for completion of "workers" course (for workers) or "Contractor/Supervisor Course" (for CONTRACTOR's on-site supervisory staff) meeting the requirements for lead and asbestos abatement. Training must meet USEPA, OSHA and state DPH criteria, and all subsequent annual refresher training certificates meeting same requirements.
 - ii. All workers must have 40 Hour HAZWOPER training per OSHA 29 CFR 1910.120. Workers must also be current on annual 8 Hour refresher training.
 - iii. All workers must have current 10 Hour Construction Safety training per OSHA 29 CFR 1926.
- 5) Certification of Medical Requirements: For each worker, a written medical opinion prepared and signed by a licensed physician indicating the following:
- i. The name of the employee.
 - ii. Physician's written opinions, including approval to wear a respirator during work activities.
- 6) Air Sampling Results:
- i. Personal air sampling for PCBs, lead, and/or asbestos shall be completed and results provided to the ENGINEER and OWNER within 24 hours after receipt. The ENGINEER and OWNER shall be notified immediately of any airborne levels in excess of the anticipated concentrations.
 - ii. Written sampling results shall be provided within five (5) working days of the date of collection. The written results shall be signed by testing laboratory analyst, testing laboratory principal, and the CONTRACTOR's CIH.
 - iii. The air sampling results shall be maintained on-site by the CONTRACTOR. The air monitoring log shall contain the following information for each sample: sample collection date, date sample was analyzed, sample number, sample type, sample period (start time, stop time), sampling pump manufacturer (i.e., model and serial number), average flow rate (in liters per minute, L/min), total air volume sampled (in Liters, L), results and location/activity/name where sample was collected. In addition, the log shall identify the calibration method used to calibrate the sampling pumps, the name and location of the laboratory conducting the sample analyses, print name, signature, and date block for the CIH who conducted the sampling and the review verifying the accuracy of the information.
- 7) Provide Safety Data Sheets (SDS) for all products used, including but not limited to, paint strippers, mastic removal chemicals, and any other chemicals that become part of the PCB waste. These products must be approved by the OWNER's EH&S prior to use.

- C. The CONTRACTOR shall prepare a written PCB Disposal Plan that details waste profiling, manifesting, handling, packaging, transportation and disposal of PCB waste generated during the project. At a minimum, the PCB Disposal Plan shall identify:
1. Waste packaging, labeling, placarding and manifesting procedures. The OWNER will be the Generator and will sign all waste profiles and manifests as detailed and in accordance with Section 02 41 19 (Selective Structure Demolitions).
 2. Transporter and Acceptance Facility Qualifications: Written evidence that the landfill or disposal facility is approved for disposal of PCB bulk product waste and/or PCB remediation waste by the USEPA, state and local regulatory agencies. Copies of signed agreement(s) between the CONTRACTOR, and each Subcontractor to include transporters and the waste disposal facility to accept and dispose of all PCB waste generated during the performance of this Contract.
 - a. The name, address, contact person(s), 24-hour contact number of the facilities to which the PCB waste will be transported.
 - b. Letter of intent and approved profiles for each facility to accept PCB bulk product waste, PCB-containing items and PCB-contaminated soil.
 - c. The name, address, contact person(s) for proposed waste transporters, including EPA identification number for firms that will transport hazardous waste. Copies of permits and licenses of RCRA hazardous waste transporters. For hazardous waste transporters, provide permits and licenses for every state affected by transport to the proposed accepted facility.
 3. The route(s) by which the waste will be transported to the designated disposal facility, and states or territories through which the waste will pass.
- D. The CONTRACTOR's Competent Person shall prepare a written PCB Close-out report. Submittal shall be prepared upon receipt of all waste shipment certification records. Upon its completion, the PCB Abatement Close-out Report will be submitted to the ENGINEER and OWNER. The Report will include, at a minimum, the following:
1. Site description.
 2. A copy of the Daily Progress Log which describes field activities and procedures.
 - a. All entries in the log shall be made in non-washable, permanent ink pen. No pencil entries shall be permitted.
 - b. The Competent Person shall document all Work performed daily, and note all inspections.
 3. Verification and re-occupancy wipe sample locations and analytical results.
 4. Photos of the remediation activities including containments, before and after remediation actions.
 5. Waste characterization laboratory analysis reports, if required.
 6. Waste transport and disposal manifests and disposal logs.
 7. Copy of PCB notification with acknowledgment from the disposal facility/landfill.
- E. Submit to ENGINEER, copies of all analytical data. Analytical data shall be kept confidential, and distributed to the ENGINEER.

- F. Provide the ENGINEER with hazardous waste manifests for Generator signature, and copies of all approved profiles and related paperwork, no less than seven (7) days in advance of shipping waste off-site.
- G. Submit to the ENGINEER all hazardous waste manifests (OWNER receives the original "Generator's Initial Copy" the day the load leaves the site).
- H. Submit to the ENGINEER directly, within seven (7) days of receipt, copies of facility-signed waste manifests.

1.4 REGULATORY REQUIREMENTS

- A. The following regulations are cited for the information and guidance of the CONTRACTOR. The list of regulations cited below is not all inclusive; the CONTRACTOR shall be responsible for a thorough knowledge and full implementation of all applicable requirements for PCB removal, collection, transport, and disposal:
 - 1. USEPA, 40 CFR 761, Toxic Substances Control Act (TSCA) Regulations.
 - 2. USEPA, Memorandum from Suzanne Rudzinski to Regional TSCA and RCRA Division Directors, EPA Regions 1-10, "SUBJECT: PCB Bulk Product Waste Reinterpretation", dated October 24, 2012.
 - 3. USEPA, 40 CFR 240-299, Resource Conservation Recovery Act (RCRA) Regulations.
 - 4. U.S. Department of Transportation, 49 CFR 100-177 and 350-399, Hazardous Materials Regulations.
 - 5. Connecticut General Statutes, 22a-463 through 469.
 - 6. U.S. Department of Occupational Safety and Health Administration (OSHA), 29 CFR 1910 and 1926 Regulations.
 - 7. OSHA 29 CFR 1910.120 Hazardous Waste Operations and 29 CFR 1910.1200 Hazard Communications.
 - 8. OSHA 29 CFR 1926.62 (Lead) and 1926.1101 (Asbestos).

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Provide packaging in accordance with 49 CFR 172 & 173 such as 30 or 55 gallon capacity fiber, plastic, or metal drums, Gaylord Boxes or other Intermediate Bulk Containers (IBCs), or non-siftable bulk containers, capable of being sealed air and water tight if PCB waste has the potential to damage or puncture disposal bags.
- B. All materials shall be delivered to the work site in the original packages, containers or bundles bearing the name of the manufacturer, the brand name and product technical description.
- C. No damaged or deteriorating materials shall be used. If material becomes contaminated with PCBs, the material shall be disposed of as PCB waste material. The cost to dispose of this material shall be at the expense of the CONTRACTOR.

- D. All polyethylene sheeting shall be fire retardant, and in roll size to minimize the frequency of joints, with factory label indicating six (6) mil thickness.
- E. Tape (or equivalent) capable of sealing joints in adjacent polyethylene sheeting and for the attachment of polyethylene sheeting to finished or unfinished surfaces must be capable of adhering under both dry and wet conditions.
- F. Containers for storage, transportation and disposal of PCB waste material shall be impermeable and both air and watertight.
- G. Any planking, bracing, shoring, barricades and/or temporary sheet piling necessary to appropriately perform work activities shall conform to all applicable Federal, state and local regulations.
- H. Provide all ladders and scaffolding and/or staging as necessary to accomplish the Work. Scaffolding may be of suspension type or standing type such as metal tube and coupler, tubular welded frame, pole or outrigger type or cantilever type. The type, erection and use of all scaffolding and ladders shall comply with all applicable OSHA construction industry standards.
- I. All dry vacuuming and air filtration devices shall be performed with High Efficiency Particulate Absolute (HEPA) filter-equipped industrial vacuums conforming to ANSI Z9.2.
- J. Chemicals used to remove or clean PCBs from surfaces must be approved by ENGINEER and OWNER prior to use.

2.2 PERSONNEL PROTECTION

- A. The CONTRACTOR shall utilize all appropriate engineering controls and safety and protective equipment while performing the work in accordance with applicable OSHA, USEPA, USDOT, CTDEEP, CTDPH regulations and other Contract provisions.
- B. The CONTRACTOR shall provide and require all workers to wear protective clothing in the Regulated Areas where PCB contamination exists or is likely to exist. Protective clothing at a minimum shall include impervious coveralls with elastic wrists and ankles, head covering, gloves and foot coverings.
- C. Respiratory protection shall be provided and selection shall conform to the requirements of OSHA 29 CFR 1910.134 and 42 CFR Part 84. A formal respiratory protection program must be implemented in accordance with 29 CFR 1910.134.
- D. All other personnel protective equipment (i.e. hardhat, work boots, safety glasses, hearing protection, etc.) required to perform the PCB abatement work activities shall conform to all applicable Federal, state and local regulations and other applicable provisions of the Contract.

- E. All other qualified and authorized persons of the ENGINEER, OWNER and/or CONTRACTOR entering into a Regulated Area shall be required to adhere to the requirements of personnel protection as stated in this section and all other applicable provisions of the Contract. All unqualified or unauthorized persons shall be escorted outside of the Regulated Areas.

2.3 SIGNS, LABELS AND CONTAINERS

- A. Provide warning signs and barrier tapes to all approaches to PCB Work Areas/Control Areas. Locate signs at such distance that personnel may read the sign and take the necessary protective steps required before entering the area.
 - 1. Post all emergency exits as emergency exists only on the Work Area side, and post PCB caution signs on the non-Work Area side.
 - 2. Provide all non-Work Area stairs and corridors accessible to the PCB Work Area with warning tapes at the base of stairs and beginning of corridors. Warning tapes shall be in addition to caution signs.
- B. Provide the appropriate "Large PCB Marking" or "Small PCB Marking" (per 40 CFR 761) of sufficient size to be clearly legible for display on all waste containers (e.g., bags, boxes, roll-offs, or drums, etc.) which will be used to contain or transport PCB contaminated material. Per 49 CFR Parts 171 and 172, the U.S. DOT requires the name and UN number of the material to be on the bags or drums, and if shipped in bulk (e.g., roll-offs, Gaylord boxes, etc.) the bulk container must also be labeled: Polychlorinated biphenyl, solid mixture, UN3432. Bulk containers are defined under 49 CFR 179.8 as greater than 119 gallons or 882 pounds.
- C. Provide 6 mil polyethylene disposal bags with PCB caution labels.
 - 1. The "Small PCB Marking" may be used. Bags shall also be labeled with U.S. DOT required markings per 49 CFR 172, Polychlorinated biphenyl, sold mixture UN3432.
 - 2. Labeled PCB waste containers or bags shall not be used for non-PCB waste or trash. Any material placed in labeled containers or bags, whether turned inside out or not shall be handled and disposed of as PCB waste.
- D. All PCB waste material shall be labeled with an "out of service" date.
- E. PCB wastes shall be segregated in drums by source: greater than fifty (50) ppm and less than fifty (50) ppm. Bulk product waste (e.g., paint stripped from pipe, caulk and building materials or other man-made structures where the PCB bulk product waste, such as caulk or paint, has not been removed from the building material) shall be segregated from PCB remediation waste (e.g., PPE worn while stripping paint from pipe or other substrate materials). Drums, roll-offs, and other shipping containers shall be clearly marked as to the content.

PART 3 – EXECUTION

3.1 GENERAL

- A. All labor, materials, tools, equipment, services, testing, and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these specifications shall be provided by the CONTRACTOR.
- B. Prior to the beginning of this Work, the ENGINEER and the CONTRACTOR's Competent Person shall perform a visual survey of each work area and review conditions at the site for safety reasons. In addition, the CONTRACTOR shall instruct all workers in all aspects of personal protection, work procedures, emergency evacuation procedures and use of equipment including procedures unique to this work.
- C. No work shall commence until the CONTRACTOR's PCB HASP, PCB Work Plan and PCB Disposal Plan have been accepted by the ENGINEER.
- D. CONTRACTOR shall submit the proposed abatement schedule and emergency contact and communication plan to the OWNER's Construction and Operation's personnel (Project Team) responsible for the facility where the abatement will take place. CONTRACTOR shall meet with the OWNER and ENGINEER to discuss abatement schedule and sequencing and contingency plan for emergencies prior to initiating any abatement work.
- E. CONTRACTOR shall implement the engineering controls necessary to eliminate the deposition of any potential/perceived PCB-laden fugitive dust, particulate, flecks, paint chips, caulk, etc. on the building/structure, earthen and bituminous surfaces abutting, adjacent to, and/or surrounding the equipment/materials under abatement/removal. Should the CONTRACTOR's engineering controls prove insufficient, the CONTRACTOR shall at his own expense remove the impacted building material, and earthen or bituminous surfaces for off-site disposal and restore the area to its original condition.

3.2 PRE-ABATEMENT CONFERENCE

- A. Prior to start of preparatory PCB Work, the CONTRACTOR shall attend a pre-abatement conference attended by the OWNER, ENGINEER and affected Facility personnel.
- B. Agenda for this conference shall include but not necessarily be limited to:
 - 1. CONTRACTOR's scope of Work, PCB Work Plan, and schedule to include number of workers and shifts.
 - 2. CONTRACTOR's safety and health precautions including protective clothing and equipment and decontamination procedures.
 - 3. CONTRACTOR's Competent Person duties, functions and authority.
 - 4. CONTRACTOR's Work procedures, including:
 - a. Methods of job site preparation and removal methods.
 - b. Disposal procedures.
 - c. Cleanup procedures.
 - d. Fire exits and emergency procedures.

5. CONTRACTOR's required pre-work and on-site submittals, documentation, and postings.
6. Handling of movable objects.
7. Storage of removed PCB materials.
8. Waste disposal requirements and procedures.

3.3 PRE-ABATEMENT WORK

- A. In addition to this Article, CONTRACTOR shall also follow all pre-abatement work as detailed and in accordance with Section Section 02 41 00, Demolition.
- B. Shut down and lockout/tag out any equipment that presents a hazard in the area where abatement activities will take place. Coordinate the shut down and lockout/tag out of any equipment with the OWNER and ENGINEER in advance.
- C. Provide sufficient electrical power if the Owner is not able to supply power. All equipment must be protected by GFCI outlets at the source of power in accordance with applicable electrical codes and OSHA requirements.
- D. The shutdown and/or isolation of heating, cooling, and ventilating air systems to prevent contaminated material from migrating to other areas of the building/structure must be coordinated with the OWNER. Clean the area of debris and remove all loose equipment and articles.
- E. All operable windows within the interior work area and all operable windows within and near the exterior work area shall be closed.
- F. Water service may not always be available at the Site. CONTRACTOR shall supply sufficient water for each shift to operate the decontamination units as well as to maintain the work areas adequately wetted.
- G. Ladders, lifts, and scaffolds shall be inspected daily by the CONTRACTOR's Competent Person. Work performed above six (6) feet shall be performed in accordance with the OSHA fall protection standards including the use of fall prevention and arrest equipment.

3.4 CONSTRUCTION OF INTERIOR AND EXTERIOR CONTAINMENTS

- A. The CONTRACTOR shall indicate in the PCB Work Plan where interior and exterior containment may be required and where wet and dry methods of work will be used.
- B. The CONTRACTOR shall pre-clean the Work Area prior to the start of any abatement work or setting up containments. The Work Area shall be HEPA vacuumed to remove any dust or debris. Wet methods may also be used to pre-clean the area. Do not use methods that raise dust such as sweeping or using vacuum equipment that is not properly equipped with HEPA filters.

- C. The CONTRACTOR is responsible for protecting all fixed objects that are too large to remove and that will remain inside the containment. Fixed objects shall be enclosed with one layer of six (6) mil polyethylene sheeting and sealed with tape.
- D. The Work Area/setup must be inspected and approved by the ENGINEER and OWNER's EH&S prior to beginning any abatement work.
- E. Only qualified personnel are allowed in the containments.
- F. Containment shall be full, floor, ceiling and all apertures. In areas where this is not possible, an alternative containment plan must be provided to the ENGINEER and OWNER. No work shall proceed until written approval is received from ENGINEER.
- G. The containment shall be equipped with a decontamination shower room. The shower room shall be of sufficient capacity to accommodate the number of workers. One (1) shower stall shall be provided for each eight (8) workers. Showers shall be equipped with hot and cold running water through the use of an electric hot water heater supplied by the CONTRACTOR. No worker or other person shall leave a Regulated Area without showering. All shower water shall be collected and analyzed for PCBs to determine proper disposal.
- H. Fire safety aspects and procedures for evacuation shall be incorporated into the planning. Conspicuously label and maintain emergency and fire exits from the Regulated Areas.
- I. When containments are required, negative pressure must be maintained in each active interior work area until the area achieves satisfactory verification sampling results. Exhaust air filtration units (negative air units) shall be equipped with HEPA filters capable of providing sufficient air exhaust to create a minimum pressure differential of 0.02 inches of water column. Negative air equipment will be set up to allow a sufficient flow of air through the clean room and the shower facility and then through the containment. A minimum of four (4) air changes per hour must also be provided by the negative air equipment.
- J. All containments must be constructed using two layers of six (6) mil polyethylene sheeting. The CONTRACTOR shall post warning signs to deter unauthorized personnel from entry.

3.5 REMOVAL OF PCB MATERIALS – GENERAL

- A. PCB-containing materials shall be removed in accordance with the Contract Documents and the approved PCB Work Plan. The removal of the PCB materials may require removing the entire item and disposing of it as the appropriate classification of PCB waste. Items with caulk or paint at equal to or greater than fifty (50) ppm PCBs must be disposed of as bulk product waste. Items with caulk or paint that contains less than fifty (50) ppm PCBs must be disposed of in compliance with CTDEEP requirements.

- B. Items such as metal and other non-porous equipment/materials from which PCBs are removed may be decontaminated by physical or chemical means such that no visible residue remains.
 - 1. For paint removal, the decontaminated components must meet the appearance of "white metal" in accordance with the NACE 2 Standard.
 - 2. The removal of the PCB materials may require the use of paint strippers, scrapers, mastic removal chemicals, or other methods/procedures to ensure complete removal. All chemicals used must be approved by the ENGINEER and OWNER prior to use.
- C. Mechanical cutting or grinding of PCB materials is not permitted, unless the equipment has factory- equipped HEPA filtered exhaust, is done in full negative air enclosures, and has been approved by OWNER.
- D. Power or pressure washers are not permitted for PCB removal or clean-up procedures unless approved by OWNER.
- E. All construction and demolition debris determined to be contaminated with PCB shall be handled and disposed of as identified in the approved Contractor Work Plan. Non-PCB contaminated demolition debris shall be segregated from PCB contaminated demolition debris.
- F. All PCB waste material must be stored at or near the point of generation. The CONTRACTOR shall be in control of the waste and inspect the waste containers daily. Any compliance issues or deficiencies must be immediately corrected.
- G. The CONTRACTOR is required to provide temporary protection of the building (i.e. roof, window openings, construction joints, etc.) at the end of each Work shift so as to maintain the building in a watertight condition.
- H. PPE as specified in the PCB HASP shall be utilized and worn during all removal operations until the PCB Regulated/Containment and Control Areas are cleared.
- I. Following completion of the Work and after all accumulations of PCB waste materials have been containerized, the decontamination procedures set forth in Article 3.6 of this Specification shall be followed.
- J. If necessary, finishes damaged by PCB abatement activities shall be restored prior to final payment. Restoration methods shall be described in the PCB Abatement Plan or CONTRACTOR's PCB Work Plan. Finishes unable to be restored shall be replaced under this Contract, unless determined otherwise by the OWNER.
- K. Dry sweeping and any other methods that raise dust are prohibited. All vacuums used during abatement or final cleaning activities shall be designed for abatement work and be equipped with HEPA filters.
- L. Negative air machines used during abatement activities shall be equipped with HEPA filters and must discharge to the outside of the building. Upon completion of the project all HEPA filters shall be properly disposed of.

3.6 EQUIPMENT AND AREA DECONTAMINATION AND VERIFICATION TESTING

- A. When removal of PCB materials is completed, the decontamination process shall consist of vacuuming (with a HEPA filter), wet wiping/mopping and a repeated vacuuming (with a HEPA filter) of the entire Work Area. All surfaces in and around the Work Area must be free of dust generated during the Work.
- B. Decontaminate all tools and equipment in accordance with the procedures specified in 40 CFR 761.79(c) before removal from the work area.
- C. If dust or debris has migrated to areas of the building other than the immediate Work Area, those areas shall be incorporated into the Work Area and thoroughly decontaminated to ensure all visible dust generated by the activity is eliminated.
- D. Uncontaminated dust barriers and other protective sheeting shall be placed in disposable construction bags and disposed of as PCB remediation waste as specified in the CONTRACTOR's PCB Work Plan.
- E. Visually inspect the area for any remaining dust or debris. Vacuum (with HEPA filter) and wet wipe until space is clean. Dispose of vacuum contents and wet wipes as PCB bulk product waste.
- F. Upon completion of decontamination and removing temporary dust barriers, PCB verification wipe sampling and testing of PCBs on adjacent affected surfaces shall be performed by the CONTRACTOR. In addition, a final inspection shall be performed by the CONTRACTOR, ENGINEER, and OWNER. If the results of the verification testing or the visual inspection are not satisfactory, the CONTRACTOR will re-clean the affected areas at no additional expense to the OWNER. Verification wipe testing shall be performed by the CONTRACTOR after re-cleaning is completed. Any and all verification testing will be at no additional expense to the OWNER.

3.7 STORAGE AND MATERIALS

- A. If the CONTRACTOR chooses to store PCB waste material on-site prior to transport for disposal, the CONTRACTOR shall construct a secured Waste Storage Area at a location agreed to by the ENGINEER and OWNER. The Waste Storage Area shall enclose all suitable Waste Storage Containers actively in use with temporary fencing. The storage of all waste materials must be in compliance with 40 CFR 761.
- B. Unless otherwise specified by the ENGINEER and OWNER, all removed materials and debris resulting from the execution of this Work shall become the responsibility of the CONTRACTOR and removed from the premises. Material shall be removed from the site and disposed of in accordance with all applicable Federal, state and local requirements.
- C. If drums are stored outdoors, at a minimum, the exterior storage area shall be lined with 20-mil high density polyethylene (HDPE) and a containment berm provided.

The containment area shall be capable of capturing at least 110 percent (110%) of the storage volume of the largest container. The drums will be covered with a tarp or 6 mil poly sheeting.

- D. If larger items (e.g., painted pumps, piping) of PCB waste material are generated, roll-offs may be used. The roll-off(s) must either be new or in excellent condition. The roll-off(s) cannot have any holes or dents. The roll-off(s) must be double-lined with six (6) mil polyethylene and tightly covered with the cover securely fastened. Roll-offs must be properly labeled on all four sides.
- E. All waste containers shall be inspected daily. Written inspection logs will be kept by the CONTRACTOR and provided to ENGINEER and OWNER when requested. Inspection logs will be submitted to the ENGINEER upon completion of the PCB Work.
- F. Only PCB wastes shall be stored in the drums and roll-offs described in this section. All other waste materials shall be staged/stored in an area separate from the containers described here.

3.8 TRANSPORTATION OF PCB WASTE MATERIALS

- A. All transporters shall be properly licensed to transport PCB waste material in Connecticut and all other States traversed while in transit to the disposal facility. The transporters shall be under the direct control of the CONTRACTOR at all times. All spills during transport shall remain the responsibility of the CONTRACTOR. All damage or costs incurred as a result of a spill and the required cleanup process shall be borne by the transporter and/or the CONTRACTOR. The name(s) of the Transportation Company and appropriate permits/licenses shall be provided to ENGINEER and OWNER as part of the PCB Disposal Plan.
- B. Transport all PCB waste material under proper manifests as required herein and in accordance with Section 02 41 00, Demolition.
- C. Vehicles used for the transportation of PCB waste material shall be clearly marked and placarded as required by the United States DOT. All drums shall be secured to the transport vehicle to prevent movement during transport.
- D. Waste profiles and shipping documents shall be provided to the ENGINEER at least two (2) week prior to shipment for final review and signature.
- E. The CONTRACTOR shall be responsible for preparing all manifests and other required shipping documents. A representative of the OWNER will review and sign all manifests.

3.9 DISPOSAL REQUIREMENTS

- A. All drums and/or roll-offs containing federally regulated PCB Waste (50 mg/kg or greater) shall be transported to an USEPA-approved disposal facility per requirements of 40 CFR 761.60, 761.61 and 761.62 governing disposal of PCB materials. The CONTRACTOR shall be liable for all penalties associated with tardiness in delivering PCB waste to an approved disposal facility, including final certificate of destruction.
- B. State regulated PCB Waste (>1 but < 50 mg/kg) shall be disposed of at a facility that is permitted to receive such wastes (ex. Solid waste landfill permitted under RCRA Title D, RCRA hazardous landfill and facilities permitted to manage nonhazardous waste subject to 40 CFR 257.5-257.30).
- C. Any PCB waste materials which also contain other hazardous contaminants (e.g., lead) shall be disposed of in accordance with USEPA RCRA, TSCA and CTDEEP requirements.

3.10 FINAL DISPOSAL CERTIFICATIONS

- A. Upon completion of the proper disposal of PCB waste material, the CONTRACTOR shall provide:
 - 1. Written certification from the disposal facility (ies) that the items being disposed of were delivered to, accepted, and appropriately managed by the disposal facility. Certificate shall be signed by the person authorized by the disposal facility to accept PCB material for disposal.
 - 2. All original manifests including manifests associated with any re-manifesting procedures during storage and handling.
 - 3. Certificates of Destruction of Materials, if applicable.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 03 00 05

CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete, reinforcing, and related materials.
2. The Work includes:
 - a. Providing concrete consisting of portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured.
 - b. Fabricating and placing reinforcing, including ties and supports.
 - c. Design, erection, and removal of formwork.
 - d. Building into the concrete all sleeves, frames, anchorage devices, inserts, and other items required to be embedded in concrete.
 - e. Providing openings in concrete as required to accommodate Work under this and other Sections.

B. Coordination:

1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.

C. Classifications of Concrete:

1. Class “A” concrete shall be steel-reinforced and includes all concrete unless otherwise shown or indicated.
2. Class “B” concrete shall be placed without forms or with simple forms, with little or no reinforcing and includes the following:
 - a. Concrete fill.
 - b. Duct banks.
 - c. Unreinforced encasements.
 - d. Curbs and gutters.
 - e. Sidewalks.
 - f. Thrust blocks.

B. Related Sections:

1. Section 05 05 33, Anchor Systems.
2. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ACI 224R, Control of Cracking in Concrete Structures.
2. ACI 301, Specifications for Structural Concrete for Buildings.
3. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305R, Specification for Hot Weather Concreting.
5. ACI 306R, Cold Weather Concreting.
6. ACI 309R, Guide for Consolidation of Concrete.
7. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
8. ACI 347, Guide to Formwork for Concrete.
9. ACI SP-66, ACI Detailing Manual.
10. ASTM A82/A82M, Specification for Steel Wire, Plain, for Concrete Reinforcement.
11. ASTM A185/A185M, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
12. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
13. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
14. ASTM C33/C33M, Specification for Concrete Aggregates.
15. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
16. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
16. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
17. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
18. ASTM C143/C143M, Test Method for Slump of Hydraulic-Cement Concrete.
19. ASTM C150/C150M, Specification for Portland Cement.
20. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
21. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
23. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
24. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
25. ASTM C579, Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
26. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
27. ASTM D1752, Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
28. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials
29. ASTM E1745, Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

30. CRD-C 572, U. S. Army Corps of Engineers Specification for Polyvinylchloride Waterstops.
31. CRSI 1MSP, Manual of Standard Practice.

1.3 QUALITY ASSURANCE

A. Laboratory Trial Batch:

1. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
2. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
3. Perform the following testing on each trial batch:
 - a. Aggregate gradation for fine and coarse aggregates.
 - b. Slump.
 - c. Air content.
 - d. Compressive strength based on three cylinders each tested at seven days and at 28 days.
4. Submit for each trial batch the following information:
 - a. Project identification name and number (if applicable).
 - b. Date of test report.
 - c. Complete identification of aggregate source of supply.
 - d. Tests of aggregates for compliance with the Contract Documents.
 - e. Scale weight of each aggregate.
 - f. Absorbed water in each aggregate.
 - g. Brand, type, and composition of cementitious materials.
 - h. Brand, type, and amount of each admixture.
 - i. Amounts of water used in trial mixes.
 - j. Proportions of each material per cubic yard.
 - k. Gross weight and yield per cubic yard of trial mixtures.
 - l. Measured slump.
 - m. Measured air content.
 - n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28-day test, and for each design mix.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. List of concrete materials and concrete mix designs proposed for use. Include results of tests performed to qualify the materials and to establish the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.
 - b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.

- c. Concrete placement drawings showing the location and type of all joints.
 - d. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI SP-66. For walls and masonry construction, provide elevations to a minimum scale of 1/4-inch to one foot. Show bar schedules, stirrup spacing, adhesive dowels, splice lengths, diagrams of bent bars, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing.
 - 2. Product Data:
 - a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
 - 3. Samples:
 - a. Samples: Submit samples of materials as specified and as otherwise requested by ENGINEER, including names, sources, and descriptions.
- B. Informational Submittals: Submit the following:
- 1. Delivery Tickets: Copies of all delivery tickets for each load of concrete delivered to or mixed at the Site. Each delivery tickets shall contain the information in accordance with ASTM C94/C94M along with project identification name and number (if any), date, mix type, mix time, quantity and amount of water introduced.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Transportation, Delivery, and Handling:
- 1. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.
 - 2. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
 - 3. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.
 - 4. Deliver grout materials from manufacturers in unopened containers that bear intact manufacturer labeling.
 - 5. Comply with Section 01 65 00, Product Delivery Requirements.
- B. Storage:
- 1. Store formwork materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.
 - 2. Store concrete reinforcing materials to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing

- does not come into contact with the ground. Space framework or blocking supports to prevent excessive deformation of stored materials.
3. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight.
 4. For storage of concrete materials, provide bins or platforms with hard, clean surfaces.
 5. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type II.
- B. Aggregates: ASTM C33/C33M.
 1. Fine Aggregate: Clean, sharp, natural sand free of loam, clay, lumps, and other deleterious substances. Dune sand, bank run sand, and manufactured sand are unacceptable.
 2. Coarse Aggregate:
 - a. Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.
 - b. Coarse aggregate shall comply with the following:
 - 1) Crushed stone, processed from natural rock or stone.
 - 2) Washed gravel, either natural or crushed. Slag, pit gravel, and bank-run gravel are not allowed.
 - c. Coarse Aggregate Size: ASTM C33/C33M, Nos. 57 or 67, unless otherwise approved by ENGINEER.
- C. Water: Clean, potable.
- D. Admixtures:
 1. Air-Entraining Admixture: ASTM C260.
 2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 3. Water Reducing and Set-Adjusting Admixtures: ASTM C494/C494M, Types D and E.
 4. High Range Water-Reducing Admixture: ASTM C494/C494M, Type F/G.
 5. Use only admixtures that have been tested and approved in the mix designs.
 6. Do not use calcium chloride or admixtures containing chloride ions.
 7. Hydration Control Admixtures, ASTM C494, Type D may be used to extend the time of proper workability. That time period will be agreed upon at the pre-installation meeting:
 - a) Eucon DS or Stasis by The Euclid Chemical Company
 - b) MasterSet Delvo by BASF

2.2 CONCRETE MIX

- A. General:
 - 1. Normal weight: 145 pounds per cubic foot.
 - 2. Use air-entraining admixture in all concrete. Provide not less than four percent, nor more than eight percent, entrained air for concrete exposed to freezing and thawing, and provide from three to five percent entrained air for other concrete.
- B. Proportioning and Design of Class “A” Concrete Mix:
 - 1. Minimum compressive strength at 28 days: 4,500 psi.
 - 2. Maximum water-cement ratio by weight: 0.42.
 - 3. Minimum cement content: 564 pounds per cubic yard.
- C. Proportioning and Design of Class “B” Concrete Mix:
 - 1. Minimum compressive strength at 28 days: 3,000 psi.
 - 2. Maximum water-cement ratio by weight: 0.50.
 - 3. Minimum cement content: 517 pounds per cubic yard.
- D. Slump Limits:
 - 1. Proportion and design mixes to result in concrete slump at point of placement of not less than two inches and not more than four inches.
 - 2. When using high-range water reducers, slump prior to addition of admixture shall not exceed three inches. Slump after adding admixture shall not exceed nine inches at point of placement.
- E. Adjustment of Concrete Mixes:
 - 1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
 - 2. Submit for ENGINEER’s approval laboratory test data for adjusted concrete mix designs, including compressive strength test results.
 - 3. Implement adjusted mix designs only after ENGINEER’s approval.
 - 4. Adjustments to concrete mix designs shall not result in additional costs to OWNER.

2.3 FORM MATERIALS

- A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection. CONTRACTOR shall be responsible for designing the formwork system to resist all applied loads including pressures from fluid concrete and construction loads.
- B. Smooth Form Surfaces: Acceptable panel-type to provide continuous, straight, smooth, as-cast surfaces in accordance with ACI 301.

- C. Unexposed Concrete Surfaces: Material to suit project conditions.
- D. Provide 3/4-inch chamfer at all external corners. Chamfer is not required at re-entrant corners unless otherwise shown or indicated.
- E. Form Ties:
 - 1. Provide factory-fabricated, removable, or snap-off metal form ties, that prevent form deflection and prevent spalling of concrete surfaces upon removal. Materials used for tying forms are subject to approval of ENGINEER.
 - 2. Unless otherwise shown or indicated, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5 inches from outer surface of concrete. Unless otherwise shown or indicated, provide form ties that, upon removal, will leave a uniform, circular hole not larger than one-inch diameter in the concrete surface.
 - 3. Ties for exterior walls, below-grade walls, and walls subject to hydrostatic pressure shall be provided with waterstops.
 - 4. Wire ties are unacceptable.

2.4 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed bars.
- B. Welded Wire Fabric: ASTM A185/A185M.
- C. Steel Wire: ASTM A82/A82M.
- D. Provide supports for reinforcing including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing in place.
 - 1. Use wire bar-type supports complying with CRSI MSP1 recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
 - 2. For slabs on grade, use precast concrete blocks, four inches square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.
 - 3. For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP1.
 - 4. Provide precast concrete supports over waterproof membranes.
- E. Adhesive Dowels:
 - 1. Dowels:
 - a. Dowel reinforcing bars shall comply with ASTM A615, Grade 60.
 - 2. Adhesive:
 - a. For requirements for adhesive, refer to Section 05 05 33, Anchor

Systems.

2.5 RELATED MATERIALS

A. Waterstops:

1. PVC Waterstops:

- a. Manufacturers: Provide products of one of the following:
 - 1) W.R. Meadows, Inc.
 - 2) Greenstreak Plastic Products Company.
 - 3) Or equal.
- b. Waterstops shall comply with CRD-C 572. Do not use reclaimed or scrap material.
- c. Minimum Thickness: 3/8-inch.
- d. Provide waterstops with minimum of seven ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be minimum 1/8-inch in height.
- e. Construction Joints: Waterstops shall be six-inch wide flat-strip type.
- f. Expansion Joints: Waterstops shall be nine-inch wide centerbulb type.

2. Hydrophilic Waterstops:

- a. Products and Manufacturers: Provide one of the following:
 - 1) Duroseal Gasket, by BBZ USA, Inc.
 - 2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
 - 3) Hydrotite, by Greenstreak Plastic Products Company.
 - 4) Or equal.
- b. Hydrophilic waterstop materials shall be bentonite-free and shall expand by minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
- c. Waterstop material shall be composed of resins and polymers that absorb water and cause a completely reversible and repeatable increase in volume.
- d. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
- e. Select material in accordance with manufacturer's recommendations for type of liquid to be contained.
- f. Minimum cross-sectional dimensions: 3/16-inch by 3/4-inch.
- g. Location of hydrophilic waterstops shall be as shown or indicated on the Drawings, or where approved by ENGINEER.
- h. Hydrophilic Sealant: Shall adhere firmly to concrete, metal, and PVC in dry or damp condition and be indefinitely elastic when cured.
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Duroseal Paste, by BBZ USA, Inc.
 - b) Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
 - c) Hydrotite, by Greenstreak Plastic Products Company.
 - d) Or equal.

- B. Vapor Retarder:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
 - b. Griffolyn 10-mil, by Reef Industries.
 - c. Moistop Ultra, by Fortifiber Industries.
 - d. Or equal.
 - 2. Vapor retarder membrane shall comply with the following.
 - a. Water Vapor Transmission Rate, ASTM E96/E96M: 0.04 perms or lower.
 - b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
 - c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
 - d. Provide accessories by same manufacturer as vapor retarder.
- C. Membrane-Forming Curing Compound: ASTM C309, Type I.
- D. Epoxy Bonding Agent:
 - 1. Two-component epoxy resin bonding agent.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Sikadur 32, Hi-Mod LPL, by Sika Corporation.
 - b. Eucopoxy LPL, by the Euclid Chemical Company.
 - c. Or equal.
- E. Epoxy-Cement Bonding Agent:
 - 1. Three-component blended epoxy resin-cement bonding agent.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Sika Armatec 110 EpoCem, by Sika Corporation.
 - b. Duralprep A.C., by Euclid Chemical Company.
 - c. Or equal.
- F. Preformed Expansion Joint Filler:
 - 1. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).
- G. Joint Sealant and Accessories:
 - 1. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07 92 00, Joint Sealants.

2.6 GROUT

- A. Non-shrink Grout:
 - 1. Pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site.
 - 2. Minimum 28-day Compressive Strength: 7,000 psi.
 - 3. Products and Manufacturers: Provide one of the following:
 - a. MasterFlow 928, by BASF, Inc.
 - b. Five Star Grout, by Five Star Products, Inc.

- c. Hi-Flow Grout, by Euclid Chemical Company.
 - d. Or equal.
 - 4. Comply with ASTM C1107/C1107M, Grade C and B (as modified below) when tested using amount of water required to achieve the following properties:
 - a. Fluid consistency (20 to 30 seconds) shall be in accordance with ASTM C939.
 - b. At temperatures of 45, 73.4, and 95 degrees F.
 - 5. Length change from placing to time of final set shall not have shrinkage greater than the expansion measured at three or fourteen days. Expansion at three or fourteen days shall not exceed the 28-day expansion.
 - 6. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.
 - 7. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.
- B. Epoxy Grout:
- 1. Pre-packaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
 - 2. Minimum Seven-day Compressive Strength: 14,000 psi, when tested in accordance with ASTM C579.
 - 3. Products and Manufacturers: Provide one of the following:
 - a. Euco High Strength Grout, by Euclid Chemical Company.
 - b. Sikadur 42, Grout Pak, by Sika Corporation.
 - c. Five Star Epoxy Grout, by Five Star Products, Inc.
 - d. Or equal.
- C. Grout Fill:
- 1. Grout mix shall consist of cement, fine and coarse aggregates, water, and admixtures complying with requirements specified in this Section for similar materials in concrete.
 - 2. Proportion and mix grout fill as follows:
 - a. Minimum Cement Content: 564 pounds per cubic yard.
 - b. Maximum Water-Cement Ratio: 0.45.
 - c. Maximum Coarse Aggregate size: 1/2-inch, unless otherwise indicated.
 - d. Minimum 28-day Compressive Strength: 4,000 psi.

PART 3 – EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the substrate and the conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 FORMWORK

- A. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation, and position.
- B. Provide openings in formwork to accommodate the Work of other trades. Accurately place and securely support items required to be built into formwork.
- C. Clean and adjust forms prior to placing concrete. Apply form release agents or wet forms as required. Re-tighten forms during and after concrete placing, when required, to eliminate cement paste leaks.
- D. Removing Formwork:
 - 1. Comply with ACI 301 and ACI 347, except as otherwise indicated in the Contract Documents.
 - 2. Do not remove formwork and shoring until supported concrete members have acquired minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field-cured specimens may be submitted to ENGINEER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated in the Contract Documents.
 - 3. Removal time for formwork is subject to ENGINEER's acceptance.
 - 4. Repair form tie-holes following in accordance with ACI 301.

3.3 REINFORCING, JOINTS, AND EMBEDDED ITEMS

- A. Comply with the applicable recommendations of Laws and Regulations and standards referenced in this Section, including CRSI MSP1, for details and methods of placing and supporting reinforcing.
- B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials which act to reduce or destroy bond between reinforcing material and concrete.
- C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers, and hangers, as required.
 - 1. Place reinforcing to obtain minimum concrete coverages as shown on the Drawings and as required in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
 - 2. Do not secure reinforcing to formwork using wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.

- D. Provide sufficient quantity of supports of strength required to carry reinforcing. Do not place reinforcing more than two inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
- E. Splices: Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown or indicated for minimum lap of spliced bars, as shown on the Drawings.
- F. Install welded wire fabric in lengths as long as practical, lapping adjoining sections a minimum of one full mesh.
- G. Do not place concrete until reinforcing is inspected and ENGINEER indicates that conditions are acceptable for placing concrete. Concrete placed in violation of this paragraph will be rejected. Notify ENGINEER in writing at least two working days prior to proposed concrete placement.
- H. Joints:
 - 1. Provide construction, isolation, expansion, and control joints as indicated or required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs-on-grade to stabilize differential settlement and random cracking.
 - 2. In walls, locate joints at a maximum spacing of 40 feet and approximately 12 feet from corners.
 - 3. In foundation slabs and slabs-on-grade, locate joints at intervals of approximately 40 feet.
 - 4. In mats and structural slabs and beams, locate joints in compliance with ACI 224R.
 - 5. Locations of joints shall be in accordance with the Contract Documents and as approved by ENGINEER in the Shop Drawings.
 - 6. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously-placed concrete to amplitude of 1/4-inch.
- I. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by, cast-in-place concrete. Use setting diagrams, templates, and instructions provided under other Sections for locating and setting. Refer to Paragraph 1.1.B of this Section. Do not embed in concrete uncoated aluminum items. Where aluminum items are in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.
- J. Adhesive Dowels:
 - 1. Adhesive dowels shall be reinforcing bar dowels set in an adhesive in hole drilled into hardened concrete. Comply with adhesive system manufacturer's installation instructions regarding hole diameter, drilling method, embedment depth required to fully develop required tensile strength, and hole cleaning

and preparation instructions. Unless more-stringent standards are required by adhesive system manufacturer, comply with the following.

2. Drill holes to adhesive system manufacturer's recommended diameter and depth to develop required tensile strength. Where indicated on the drawings, hole depths greater than required for tensile development shall be provided. Hammer-drill holes. Cored holes are not allowed.
3. Embedment depths shall be based on concrete compressive strength of 2,000 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.
4. Determine location of existing reinforcing steel in vicinity of proposed holes prior to drilling. Adjust location of holes to be drilled to avoid drilling through or damaging existing reinforcing bars only when approved by ENGINEER.
5. Before setting adhesive dowel, hole shall be free of dust and debris using method recommended by adhesive system manufacturer. Hole shall be brushed, with manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
6. Inject adhesive into hole through injection system mixing nozzle and necessary extension tubes, placed to bottom of hole. Withdraw discharge end as adhesive is placed, but keep end of tube immersed to prevent forming air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placement.
7. Twist dowels during insertion into partially-filled hole to guarantee full wetting of bar surface with adhesive. Insert bar slowly to avoid developing air pockets.

3.4 CONCRETE PLACING

- A. Site Mixing: Use drum-type batch machine mixer, mixing not less than 1.5 minutes for one cubic yard or smaller capacity. Increase required mixing time by minimum of 15 seconds for each additional cubic yard or fraction thereof.
- B. Ready-Mixed Concrete: Comply with ASTM C94/C94M.
- C. Concrete Placing:
 1. Place concrete in a continuous operation within planned joints or sections in accordance with ACI 304R.
 2. Do not begin placing concrete until work of other trades affecting concrete is completed.
 3. Wet concrete and subgrade surfaces to saturated surface dry condition immediately prior to placing concrete.
 4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
 5. Avoid separation of the concrete mixture during transportation and placing. Concrete shall not free-fall for distance greater than four feet during placing.

6. Complete concrete placing within 90 minutes of addition of water to the dry ingredients. The use of hydration control admixtures can extend this time period. Approval from the ENGINEER is required.
- D. Consolidate placed concrete in accordance with ACI 309R using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around placing and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly-spaced locations. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or placing is not allowed.
- E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placing, and curing.
 1. In hot weather comply with ACI 305R.
 2. In cold weather comply with ACI 306R.

3.5 QUALITY OF CONCRETE WORK

- A. Make concrete solid, compact, smooth, and free of laitance, cracks, and cold joints.
- B. Concrete for liquid-retaining structures and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
- C. Cut out and properly replace to extent directed by ENGINEER, or repair to satisfaction of ENGINEER, surfaces that contain cracks or voids, are unduly rough, or are defective in any way. Patches or plastering are unacceptable.
- D. Repair, removal and replacement of defective concrete directed by ENGINEER shall be at no additional cost to OWNER.

3.6 CURING

- A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by using moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection, as required, to prevent damage to exposed concrete surfaces. Total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

3.7 FINISHING

- A. Slab Finish:
 1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Use a wood float only. Check and level surface

plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture. Slab surfaces shall receive a float finish. Provide additional trowel finishing as required in this Section.

2. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
 3. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten-foot straightedge. Grind smooth surface defects that would telegraph through applied floor covering system.
 4. Use trowel finish for the following:
 - a. Interior exposed slabs, unless otherwise shown or indicated.
 - b. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown.
- B. Apply liquid sealer/densifier to exposed interior concrete floor areas when cured and dry, in accordance with manufacturer's instructions.
- C. Formed Finish:
1. Provide smooth form concrete finish at exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces include interior water-contacting surfaces of tanks, whether or not directly visible. All surfaces shall be considered as exposed, unless buried or covered with permanent structural or architectural material. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/8-inch in height. Where surface will be coated or will receive further treatment, remove all fins flush with concrete surface.
 2. Provide rough form finish at all unexposed surfaces. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/2-inch in height.

3.8 GROUT PLACING

- A. Place grout as shown and indicated, and in accordance with grout manufacturer's instructions and recommendations. If grout manufacturer's instructions conflict with the Contract Documents, notify ENGINEER and not proceed until obtaining ENGINEER's clarification.
- B. Dry-packing is not allowed, unless otherwise indicated.

- C. Manufacturers of proprietary grout materials shall make available upon 72 hours notice the services of qualified, full-time, factory-trained employee to aid in ensuring proper use of grout materials at the Site.
- D. Placing grout shall comply with temperature and weather limitations described in Article 3.4 of this Section.

3.9 FIELD QUALITY CONTROL

- A. Site Testing Services:
 - 1. CONTRACTOR shall employ independent testing laboratory to perform field quality control testing for concrete. ENGINEER will direct where samples are obtained.
 - 2. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
- B. Quality Control Testing During Construction:
 - 1. Perform sampling and testing for field quality control during concrete placing, as follows:
 - a. Sampling Fresh Concrete: ASTM C172.
 - b. Slump: ASTM C143/C143M; one test for each concrete load at point of discharge.
 - c. Concrete Temperature: ASTM C1064/C1064M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
 - d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
 - e. Unit Weight: ASTM C138/C138M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
 - f. Compression Test Specimens:
 - 1) In accordance with ASTM C31/C31M, make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by ENGINEER.
 - 2) Cast, store, and cure specimens in accordance with ASTM C31/C31M.
 - g. Compressive Strength Tests:
 - 1) In accordance with ASTM C39/C39M; one specimen tested at seven days, and three specimens tested at 28 days.
 - 2) Concrete that does not comply with strength requirements will be considered as defective Work.
 - h. Submit test results from certified by testing laboratory to ENGINEER within 24 hours of completion of test.
 - i. When there is evidence that strength of in-place concrete does not

comply with the Contract Documents, CONTRACTOR shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42/C42M and the following:

- 1) Obtain at least three representative cores from each concrete member or suspect area of concrete at locations directed by ENGINEER.
 - 2) Strength of concrete for each series of cores will be acceptable if average compressive strength is at least 85 percent of specified compressive strength and no single core is less than 75 percent of required 28-day required concrete compressive strength.
 - 3) Testing laboratory shall submit test results to ENGINEER on same day that tests are completed. Include in test reports Project name and number (if any), date of sampling and testing, CONTRACTOR name, name of concrete testing laboratory, exact location of test core in the Work, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength, and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of the core at time of testing.
- j. Fill core holes solid with non-shrink grout in accordance with this Section and finish to match adjacent concrete surfaces.
 - k. If results of core tests are unacceptable or if it is impractical to obtain cores, perform static load test and evaluations complying with ACI 318 and ACI 350, as directed by ENGINEER.
2. CONTRACTOR shall employ testing laboratory to perform field quality testing of adhesive dowels at the Site.
- a. Testing shall comply with ASTM E488.
 - b. After adhesive system manufacturer's recommended curing period and prior to placing connecting reinforcing, proof-test for pullout ten percent of adhesive dowels installed. If one or more dowels fail the test, CONTRACTOR shall pay cost to test all dowels of same diameter and type installed on the same day as the failed dowel.
 - c. Test dowels to 60 percent of specified yield strength. ENGINEER will direct which dowels are to be tested.
 - d. Apply test loads with hydraulic ram.
 - e. Displacement of dowels shall not exceed $D/10$, where D is nominal diameter of dowel.
 - f. Dowels that fail shall be reinstalled and retested at CONTRACTOR's expense.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 03 01 30

REPAIR AND REHABILITATION OF CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to repair or rehabilitate, as required, all existing concrete shown or indicated in the Contract Documents as being repaired or rehabilitated.
2. Concrete repair and rehabilitation work shall be identified by the ENGINEER during construction. The ENGINEER shall conduct a one-day, on-site inspection of each wet well chamber and each concrete headworks channel upon removal from service and identify critical areas requiring repair by the CONTRACTOR. The ENGINEER shall provide direction to the CONTRACTOR regarding implementation of repair and rehabilitation. Concrete repair and rehabilitation will be implemented in the following:
 - a. The Dry Well, Wet Well and Headworks that have been removed from service for work required to install new equipment.
3. CONTRACTOR shall repair all damage to new concrete construction as specified in this Section except for repair Work specified in Section 03 00 05, Concrete.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the Work that must be installed with or before repair and rehabilitation of concrete.

C. Related Sections:

1. Section 03 00 05, Concrete.
2. Section 05 05 33, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASTM C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
2. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
3. ASTM C510, Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.

4. ASTM C661, Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
5. ASTM C793, Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants.
6. ASTM C794, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
7. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
8. ASTM C920, Standard Specification for Elastomeric Joint Sealants.
9. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions.
10. ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
11. ASTM D3574, Test Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams.
12. ASTM G109, Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.
13. FS TT S 00227E, Interim Federal Specification for Sealing Compound: Elastomeric Type, Multi-Component (For Calking, Sealing, and Glazing in Buildings and Other Structures).

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Product Data: Information on all products proposed for use, including manufacturer's brochures, technical data, specifications, and other applicable data.
- B. Informational Submittals: Submit the following:
 1. Manufacturer's Instructions: Manufacturer's recommended procedures for installing materials proposed for use.
 2. Special Procedure Submittals: When requested by ENGINEER, submit information on methods for supporting during demolition and repair Work existing structures, pipes, and other existing facilities affected by the Work.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery and Handling of Materials:
 1. Conform to Section 01 65 00, Product Delivery Requirements, and this Section.
 2. Clearly mark on containers manufacturer's name and label, name or title of material, manufacturer's stock number, and date of manufacture.
 3. Handle materials carefully to prevent inclusion of foreign matter.

4. Do not open containers or mix components until necessary preparatory Work has been completed and application Work is to start immediately.
- B. Storage of Materials:
1. Conform to Section 01 66 00, Product Storage and Handling Requirements, and this Section.
 2. Store only approved materials at the Site.

PART 2 – PRODUCTS

2.1 REPAIR MORTAR

- A. Product Description: Repair mortar shall be prepackaged, cement-based product specifically formulated for repairing concrete surface defects.
- B. Products and Manufacturers: Provide one of the following:
1. SikaTop 122 Plus, SikaTop 123 Plus, or SikaTop 126 Plus, by Sika Corporation.
 2. DuralTop Gel, DuralTop Flowable Mortar by Euclid Chemical Company.
 3. Or approved equal.
- C. Materials:
1. Provide a two-component, polymer-modified, Portland cement, fast-setting, trowel-grade mortar. Repair mortar shall be enhanced with penetrating corrosion inhibitor, and shall have the following properties:

Physical Property	Value	ASTM Standard
Minimum Compressive Strength at One Day	2,000 psi	C109
Minimum Compressive Strength at 28 Days	6,000 psi	C109
Minimum Bond Strength at 28 Days	1,800 psi	C882*
* Modified for use with repair mortars.		

2. Where the least dimension of the placement in width or thickness exceeds four inches, extend repair mortar by adding aggregate as recommended by repair mortar manufacturer.

2.2 EXPANSION JOINT REPAIR SYSTEM

- A. System Description: Joint repair system shall consist of two components: Preformed Joint Filler and Two-component Polyurethane Sealant.
- B. Products, Manufacturers, and Materials:

1. Preformed Joint Filler
 - a. Provide preformed expansion joint filler complying with ASTM D 1752, Type I (sponge rubber) or Type II (cork).
2. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or approved equal.
 - b. Polyurethane based, two-component elastomeric sealant complying with:
 - 1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
 - 2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 18 lbs.
 - 3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
 - 4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
 - 7) VOC Content: 220 grams per liter, maximum

2.3 ANTI-CORROSION COATING REINFORCEMENT PROTECTION

- A. Product Description: Anti-corrosion coating shall be a 3 component, solvent free, moisture tolerant, epoxy modified cementitious product formulated for reinforcement protection. Provide two coats at coverage of 40 square feet per gallon per coat.
- B. Products and Manufacturers: Provide one of the following:
 1. Sika Armatec 110 EpoCem, by Sika Corporation.
 2. Or approved equal.

2.4 PROTECTIVE SLURRY MORTAR

- A. Product Description: Material shall be two-component, polymer-modified, cementitious waterproofing and protective slurry mortar. Provide two coats at coverage of 50 square feet per gallon per coat.
- B. Products and Manufacturers: Provide one of the following:
 1. Sikatop Seal 107, by Sika Corporation.
 2. Or approved equal.

2.5 CRACK INJECTION MATERIALS

- A. Structural Crack Repair System:
 - 1. Epoxy for injection shall be low-viscosity, high-modulus moisture insensitive type.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, by Sika Corporation.
 - b. Eucopoxy Injection Resin, by Euclid Chemical Company.
 - c. Or approved equal.
- B. Non-structural Crack Repair System:
 - 1. Hydrophobic Polyurethane Chemical Grout:
 - a. Provide hydrophobic polyurethane that forms a flexible gasket.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) SikaFix HH LV, by Sika Chemical Company.
 - 2) Hydro Active Flex SLV, by De Neef Construction Chemicals, Inc.
 - 3) Or approved equal.
 - c. Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
 - d. Minimum elongation of 250 percent in accordance with ASTM D3574.
 - e. Minimum tensile strength of 150 psi in accordance with ASTM D3574.
 - 2. Hydrophilic Acrylate-Ester Resin:
 - a. Hydrophilic crack repair system shall be acrylate-ester resin that forms a flexible gasket and increase in volume by at least 50 percent when in contact with water.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Duroseal Multigel 850, manufactured by BBZ USA, Inc.
 - 2) Superflex AR, by De Neef Construction Chemicals, Inc.
 - 3) Or approved equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which the repair Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- B. ENGINEER shall inspect each tank, mark on site and identify the type of repairs to be performed. CONTRACTOR shall notify the ENGINEER to perform this inspection for each individual tank after:

1. The tank has been taken out of service.
 2. Lockout tag out has been performed.
 3. The tank has been cleaned and disinfected.
 4. All the existing collector equipment has been demolished and removed as specified.
- C. CONTRACTOR shall provide all ladders, scaffolding, and man-lifts to access the tank walls of each tank for ENGINEER's inspection.

3.2 PREPARATION

- A. Surface Preparation:
1. Initial Surface Preparation: Remove by chipping, abrasive blasting, or hydro blasting all laitance, foreign material, and unsound concrete from entire area to be repaired. Further roughen surface as specified in this Section. Where non-shrink grout or repair mortar is used, perform additional surface preparation, if any, recommended by product manufacturer.
 2. Wetting Procedure: Where repair concrete, shotcrete, or cement grout is used, and bonding agent is not required, or where repair mortar or non-shrink grout manufacturer recommends wet or saturated surface, perform the following:
 - a. Continuously apply water for at least four hours to surface being repaired. Where large surface areas are to be repaired, use fog-spray nozzles, mounted on stands, in sufficient number so that entire surface to be repaired is contacted by fog spray cloud.
 - b. Prevent concrete from drying until after repair is completed. Re-wet surfaces not yet repaired using water sprays at least a daily; should more than four days elapse without re-wetting surfaces not yet repaired, repeat the original saturating procedure.
 - c. Remove standing water in areas to be repaired before placing repair material. Provide means to remove excess water from structure.
 3. Preparation for Epoxy Bonding Agent: Where repair material manufacturer recommends use of epoxy-bonding agent, conform to recommendations of both repair material manufacturer and bonding agent manufacturer.

3.3 INSTALLATION, GENERAL

- A. Construction Tolerances: Shall be as specified in Section 03 00 05, Concrete, except as specified in this Section and elsewhere in the Contract Documents.
- B. Care shall be taken to fully consolidate repair material, completely filling all portions of space to be filled.
- C. Bring surface being repaired into alignment with adjacent surfaces, providing uniform, even surface. Surface repaired shall match adjacent existing surfaces in

texture and shall receive coatings or surface treatments, if any, provided for the existing surface adjacent to repaired surface.

D. Curing:

1. Curing of repair mortar and non-shrink grout shall be in accordance with manufacturer's recommendations, except that minimum cure period shall be three days.
2. Curing of other materials shall be in accordance with requirements of Section 03 00 05, Concrete.

3.4 REPAIR OF SURFACE DEFECTS

A. Surface defects are depressions in a concrete surface that do not extend all the way through the concrete. Surface defects can result from removal of an embedded item, removal of an intersecting concrete member, physical damage, or unrepaired rock pockets created during original placement. For spalls that result from corroded reinforcing steel or other embedment refer to Article 3.7 of this Section.

B. Preparation: Perform the following in addition to requirements of Article 3.2 of this Section:

1. Remove by chipping all loose, damaged concrete to sound material.
2. Where existing reinforcing is exposed, remove concrete to minimum of one-inch around exposed bars. If existing bars are cut through, cracked, or cross sectional area is reduced by more than 25 percent from original, immediately notify ENGINEER.
3. Score-cut perimeter of area to be repaired to minimum depth of 1/2-inch and maximum depth that will not cut existing reinforcing steel. Chip out existing concrete to the score line so that minimum thickness of repair mortar will be 1/2-inch.

C. Repair Material:

1. Completely fill the surface defect with specified repair material, in accordance with material manufacturer's instructions and the Contract Documents.
2. Perform, with repair mortar, repairs of surface defects in concrete normally in contact with water or soil, and interior surfaces of structures that contain water.
3. Repair of other surface defects may be by applying repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.

3.5 PATCHING OF HOLES IN CONCRETE

A. Fill openings less than 4-in. in their least dimension with repair mortar.

- B. Openings greater than four inches and less than 12-in. in their least dimension shall be coated with an epoxy bonding agent prior to filling with repair mortar.
- C. Openings greater than 12 inches in their least dimension shall be coated with an epoxy bonding agent prior to filling with Class "A" concrete in accordance with Section 03 00 05, Concrete.
- D. Where repaired holes are in contact with water or soil, provide hydrophilic rubber waterstop within the opening in accordance with Section 03 00 05, Concrete, prior to filling with repair material.

3.6 REPAIR OF LINED HOLES

- A. This Article applies to openings with embedded material over all or a portion of inside surface of hole. Where indicated on the Drawings, remove embedded materials and repair the hole in accordance with Article 3.5 of this Section, as modified in this Article 3.6.
- B. Where embedded material is allowed to remain, remove embedded material to at least two inches into the hole, as measured from the plane surface of concrete wall or slab, as applicable. Embedded material left in place shall be roughened or abraded for proper bonding to repair material. Completely remove substances that interfere with proper bonding.
- C. Completely remove embedded items not securely and permanently anchored into concrete.
- D. Completely remove embedded items larger than 12 inches in their smallest dimension. In lieu of removing the embedded item, where reinforcing is required as shown or indicated in the Contract Documents, weld reinforcing to embedded item to remain, provided embedded item to remain is composed of metal to which reinforcing steel can be welded.

3.7 REPAIR OF DETERIORATED CONCRETE

- A. This Article pertains to deteriorated concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, or damage due to chemical attack. Use repair mortar, as specified in this Article, for repairing deteriorated concrete. Where repaired surface will be subsequently covered with plastic liner material, coordinate finishing with requirements for installing plastic liner material.
- B. Surface Preparation: In addition to requirements of Article 3.2 of this Section, perform the following surface preparation:
 - 1. Remove loose, broken, softened, and acid-contaminated concrete by abrasive blasting and chipping to sound, uncontaminated concrete.

2. Upon completion of removal of deteriorated concrete, notify ENGINEER in writing. Allow two weeks for ENGINEER to evaluate the surface, perform testing for acid contamination if required, determine if additional concrete shall be removed, and to develop special repair details (if any) required. Should ENGINEER determine that additional concrete be removed to reach sound, uncontaminated concrete, allow another two-week period for further evaluation and testing following the additional removal.
 3. Surface preparation shall conform to recommendations of repair mortar manufacturer.
 4. Repair and rehabilitate isolated areas of exposed reinforcing bars in accordance with Article 3.4 of this Section. If extensive areas of reinforcing steel are uncovered after removal of deteriorated concrete, ENGINEER will determine the repair methods required.
- C. Repair Mortar Placing:
1. Conform to manufacturer's recommended procedures for mixing and placing repair mortar.
 2. After initial mixing of repair mortar, addition of water is not allowed.
 3. Minimum Thickness:
 - a. Install repair mortar to not less than minimum thickness recommended by manufacturer, and not less than 1/2-inch.
 - b. Where removal of deteriorated concrete results in repair thickness of less than minimum required thickness to return to original concrete surface in isolated areas totaling less than ten percent of total repair surface area, remove additional concrete to obtain at least the required minimum thickness.
 - c. Where surface area with repair thickness less than minimum required thickness exceeds ten percent of total repair area, notify ENGINEER.
 - d. Provide repair mortar so that minimum cover over existing reinforcing steel is two inches. Do not place repair mortar creating locally raised areas.
 - e. Where transitioning to or from wall surfaces not requiring repair, do not feather-out repair mortar at transition. Instead, form the transition by saw cutting a score line to not less than minimum required repair mortar depth and chip out concrete to the saw cut line. Do not cut or otherwise damage reinforcing steel.
 4. Place repair mortar to an even, uniform plane to restore concrete member to its original surface. Out-of-plane tolerance shall be such that the gap between 12-inch long straight edge and repair mortar surface does not exceed 1/8-inch, and gap between a four-foot long straight edge and repair mortar surface shall not exceed 1/4-inch. Tolerances specified in this paragraph apply to straight edges placed in any orientation at any location.
- D. Finishing:
1. Provide smooth, steel trowel finish to repair mortar.

2. When completed, there shall be no sharp edges. Provide exterior corners, such as at penetrations, one-inch radius. Interior corners shall be square, except corners to receive plastic lining which shall be made with two-inch fillet in repair mortar.

3.8 REPAIR OF EXPANSION JOINTS

- A. Surface Preparation: Remove the following from surfaces to be repaired: laitance, foreign material, and unsound concrete. Remove by chipping, abrasive blasting, or hydro blasting. Additional surface preparation, if required, shall be as recommended by expansion joint repair system manufacturer.
- B. Installation: Installation shall be as recommended by Joint Filler and Sealant manufacturer.

3.9 REPAIR OF EXPOSED REINFORCING

- A. Remove, by abrasive blasting or hydro blasting, all corrosion, foreign materials, and unsound concrete from area to be repaired.
- B. Surface shall be visually dry before applying corrosion inhibitor. Liberally apply anti-corrosion coating, 20 mils thickness per coat. Provide two coats. Time between coats shall be the longer of: one hour, or as recommended by manufacturer. Apply using rollers, brushes, or hand-pressure spray equipment.
- C. After applying final coat of allow it to dry before corrosion inhibitor or repair mortar is applied.
- D. For mortar coating, conform to Paragraphs 3.7.C, 3.7.D, 3.7.E of this Section.

3.10 PROTECTIVE SLURRY MORTAR COATING

- A. Remove, by abrasive blasting or hydro blasting, all corrosion, foreign materials, and unsound concrete from area to be repaired.
- B. Surface shall be visually dry before applying anti-corrosion coating. Liberally apply anti-corrosion coating, 20 mils thickness per coat. Provide two coats. Time between coats shall be the longer of: two hours, or as recommended by manufacturer. Apply using rollers, brushes, or hand-pressure spray equipment.
- C. Apply protective slurry mortar per manufacturer recommendations.

3.11 CRACK INJECTION

- A. Examine areas under which injection Work will be installed and locate cracks that require injection. Identify and inject cracks greater than 0.010-inch wide in structures that retain or contain water, wastewater, or similar liquid.
- B. Install injection material in accordance with crack injection manufacturer's requirements.
- C. After injecting and curing, verify that injected material penetrated the crack adequately and that there is no visible leakage through the crack. After injecting, if crack continues to leak, re-inject crack at no additional cost to OWNER until structure is watertight.
- D. If proper penetration of crack cannot be achieved, submit to ENGINEER a proposed alternate approach for modifying the specified injection procedure to properly seal the crack. In new concrete and in concrete cracked as a result of CONTRACTOR's operations, perform modifications to crack injection procedure and fully repair the crack without additional cost to OWNER or extension of the Contract Times.

3.12 SITE QUALITY CONTROL

- A. OWNER will employ and pay for services of testing laboratory for Site quality control testing. ENGINEER will direct the number of tests and specimens required, including providing necessary materials for making and facility for storing test specimens. CONTRACTOR shall make standard compression test specimens as specified in this Section under the observation of ENGINEER. CONTRACTOR shall provide:
 - 1. Necessary assistance required by ENGINEER.
 - 2. All labor, material, and equipment required, including rods, molds, thermometer, curing in heated storage box, and all other incidentals required, subject to approval by ENGINEER.
 - 3. All necessary storage, curing, and transportation required for testing.
 - 4. CONTRACTOR will be charged for cost of additional testing and investigation, if any, for Work performed that is not in accordance with the Contract Documents or is otherwise defective.
- B. Site Tests of Cement-based Grouts and Repair Mortar:
 - 1. Obtain compression test specimens during construction from first placement of each type of mortar or grout, and at intervals thereafter as selected by ENGINEER, to verify compliance with the Contract Documents. Specimens will be made by ENGINEER or ENGINEER's representative.
 - 2. Compression tests and fabrication of specimens for repair mortar and non-shrink grout will be performed in accordance with ASTM C109. Set of

three specimens will be made for each test. Tests will be made at seven days, 28 days, and additional time periods as deemed appropriate by ENGINEER.

3. Bond strength field tests during construction will be performed from first placement of each type of mortar, or grout, and at intervals thereafter selected by ENGINEER, to verify compliance with the Contract Documents.
 4. Bond strength field tests for repair mortar and non-shrink grout will be performed in accordance with ASTM C882 modified for in place construction.
 5. Material, already placed, failing to conform to the Contract Documents, is defective.
- C. Repair Concrete: Repair concrete shall be tested as required in Section 03 00 05, Concrete.

++ END OF SECTION ++

SECTION 04 00 05

MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified and required for masonry Work, including:
 - a. Providing openings in unit masonry construction to accommodate the Work under this and other Specification Sections, and building into unit masonry construction all items such as sleeves, anchorage devices, inserts and other items to be embedded in unit masonry construction for which placement is not specifically provided under other Specification Sections.
2. Extent of each type of unit masonry is shown.
3. Types of products and features required include:
 - a. Concrete unit masonry.
 - b. Brick masonry.
 - c. Masonry mortar and grout.
 - d. Masonry accessories.
 - e. Unit masonry meeting requirements of Special Inspections.
 - h. Construction Waste Management.

B. Coordination:

1. Review installation procedures under other Specification Sections and coordinate the items that must be installed with unit masonry construction Work.
2. Unit masonry construction done without built-in flashings and other built-in Work shall be removed and rebuilt at no additional cost to OWNER, even if discovered after apparent completion of unit masonry construction.
3. Coordinate Work under other Specification Sections to avoid delay of masonry construction.

C. Related Sections:

1. Section 05 50 13, Miscellaneous Metal Fabrications.
2. Section 06 10 53, Miscellaneous Rough Carpentry.
3. Section 07 11 13, Bituminous Dampproofing.
4. Section 07 21 05, Building Insulation.
5. Section 07 62 00, Sheet Metal Flashing and Trim.
6. Section 07 92 00, Joint Sealants.
8. Section 09 91 00, Painting.
9. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

- A. Referenced Standards: Standards referenced in this Section are:
1. ACI 530, Building Code Requirements for Masonry Structures.
 2. ACI 530.1, Specification for Masonry Structures.
 3. ASTM A36, Standard Specification for Carbon Structural Steel.
 4. ASTM A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
 5. ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 6. ASTM A615, Standard Specification for Deformed and Plain Carbon - Bars for Concrete Reinforcement.
 7. ASTM A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 8. ASTM A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Low-Alloy with Improved Formability.
 9. ASTM C5, Standard Specification for Quicklime for Structural Purposes.
 10. ASTM C33, Standard Specification for Concrete Aggregates.
 11. ASTM C67, Standard Test Method for Sampling and Testing Brick and Structural Clay Tile.
 12. ASTM C90, Standard Specification for Hollow Load-Bearing Concrete Masonry Units.
 13. ASTM C91, Standard Specification for Masonry Cement.
 14. ASTM C62, Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale)
 15. ASTM C129, Standard Specification for Non-loadbearing Concrete Masonry Units
 16. ASTM C136, Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates.
 17. ASTM C140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 18. ASTM C144, Standard Specification for Aggregate for Masonry Mortar.
 19. ASTM C150, Standard Specification for Portland Cement.
 20. ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes.
 21. ASTM C 216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
 22. ASTM C270, Standard Specification for Mortar for Unit Masonry.
 23. ASTM C331, Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
 24. ASTM C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 25. ASTM C404, Standard Specification for Aggregates for Masonry Grouts.
 26. ASTM C426, Standard Test Method for Linear Drying Shrinkage of Concrete Block.

27. ASTM C 652, Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
28. ASTM C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
29. ASTM C1019, Standard Test Method for Sampling and Testing Grout.
30. ASTM C1093, Practice for Accreditation of Testing Agencies for Unit Masonry.
31. ASTM C1314, Standard Test Method for Compressive Strength of Masonry Prisms.
32. ASTM D2240, Standard Test Method for Rubber Property- Durometer Hardness.
33. ASTM D2287, Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
34. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
35. ASTM E119, Standard Test Method for Fire Tests of Building Construction and Materials.
36. BIA, Technical Notes on Brick and Tile Construction.
37. BIA, Technical Bulletin 1A, Construction and Protection Recommendations for Cold Weather Masonry Construction.
38. BIA, Technical Notes on Cleaning Clay Products Masonry.
39. NCMA, Guide Specifications and Technical Bulletins.
40. UL, Design No. U 901, Bearing Wall Rating – 4 HR.; Non-bearing Wall Rating – 4 HR.
41. UL, Design No. U 902, Bearing Wall Rating – 4 HR., Alternative Detail.
42. UL, Design No. U 904, Bearing Wall Rating – 3 HR.; Non-bearing Wall Rating – 3 HR.
43. UL, Design No. U 905, Bearing Wall Rating – 2 HR.; Non-bearing Wall Rating – 2 HR.
44. UL, Design No. U 906, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
45. UL, Design No. U 907, Nonbearing Wall Rating – 3 or 4 HR.
46. UL, Design No. U 909, Nonbearing Wall Rating – 3 or 4 HR.
47. UL, Design No. U 910, Bearing Wall Rating – 4 HR.; Non-bearing Wall Rating – 4 HR.
48. UL, Design No. U 912, Bearing Wall Rating – 3 HR.; Non-bearing Wall Rating 3 HR.
49. UL, Design No. U 913, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
50. UL, Design No. U 914, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
51. UL 901, Specification for Quicklime for Structural Purposes.
52. USGBC, Leadership in Energy and Environmental Design, Reference Guide, For New Construction and Major Renovation, LEED-NC, Version 2.2.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Installer: Hire a single installer regularly engaged in preformed unit masonry installation and with successful and documented experience in erecting unit masonry of scope and type of Work required; and employs only tradesmen with specific skill and successful experience in this type of Work. Submit name and qualifications to ENGINEER with the following information for at least three successful, completed projects:
 - a. Names and telephone numbers of owners, architects or engineers responsible for project.
 - b. Approximate contract cost of unit masonry for which installer was responsible.
 - c. Amount (square feet) of unit masonry installed.
2. Laboratory Qualifications:
 - a. Testing Laboratory: In accordance with ASTM C1093.

B. Component Supply and Compatibility:

1. Obtain each type of concrete masonry unit from one Supplier, cured by one process and of uniform texture and color, or in an established uniform blend thereof.
2. Do not change source or brands of mortar products during the Project.
3. Where question of compliance to requirements of this Section arise, mortar properties Specification will take precedence over mortar proportion Specification.
4. Do not change proportions established for mortar accepted under property Specifications, and do not use products with different physical characteristics in mortar used in the Work, unless compliance with requirements of property Specifications is re-established by submitting acceptable data to ENGINEER.
5. Do not combine two air-entraining materials in mortar.

C. Regulatory Requirements: Where fire-resistance classification is shown or scheduled for unit masonry construction (four-hour, three-hour, and similar designations), comply with applicable requirements for products and installation established by UL tests referenced in this Section and authorities having jurisdiction.

D. Vibration, Seismic, and Wind Requirements: Contractor responsible for this Section shall provide seismic, vibration, and wind controls for Work specified in this Section, complying with Section 40 05 96, Vibration, Seismic, and Wind Controls.

E. Job Mock-up:

1. Prior to installing unit masonry and after ENGINEER's approval of Samples, erect job mock-ups using products, pattern bond, and joint tooling shown or specified. Build mock-up at the Site, at a location approved by the ENGINEER, of full required wall thickness. Mock-up shall be approximately 4.0 feet by 3.33 feet unless another size or location is shown as job mock-up.

Provide special features as directed, including finished opening 16 inches by 16 inches, finished end, and masonry control joint. Indicate proposed range of color, texture and workmanship to be expected in completed Work. Obtain ENGINEER's approval of visual qualities of mock-up before starting unit masonry construction. Retain and protect mock-up during construction as a standard for judging unit masonry Work. Do not alter, move, or destroy mock-up until receiving written permission by ENGINEER.

2. Build as many mock-up panels as required to obtain ENGINEER's approval.
3. Perform unit masonry construction tests per ACI 530.1. Provide to ENGINEER acceptable test results before starting masonry construction.
4. Masonry construction that does not meet standards approved on mock-up panel shall be removed and rebuilt to conform to the Contract Documents. Provide mock-up panel for the following:
 - a. Typical complete interior partition of concrete unit masonry where both sides will remain visually exposed in finished Work.

F. Masonry Pre-installation Conference:

1. Prior to starting unit masonry construction Work, schedule and hold masonry pre-installation conference at the Site, to review foreseeable methods and procedures related to unit masonry Work including:
 - a. Project requirements per the Contract Documents.
 - b. Structural concept.
 - c. Sequence of masonry construction.
 - d. Special masonry details.
 - e. Required submittals.
 - f. Standard of workmanship.
 - g. Prism tests or mortar, grout sample and unit masonry tests results.
 - h. Quality control requirements.
 - i. Job organization and availability of products, tradesmen, equipment, and facilities needed to conform to Progress Schedule.
 - j. Masonry control and expansion joint location and materials.
 - k. Modular planning requirements.
 - l. Weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
 - m. Required special inspection, testing, and certifying procedures.
 - n. Compliance with building codes and other Laws and Regulations.
 - o. Construction Waste Management Plan requirements.
2. Attendance is mandatory for the following:
 - a. CONTRACTOR's Site superintendent.
 - b. Masonry Subcontractor's Site superintendent.
 - c. Masonry Subcontractor's foreman.
 - d. Authorized representative of unit masonry Suppliers.
 - e. ENGINEER.
 - f. Special Inspection Coordinator.
3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.

4. CONTRACTOR shall record discussions of conference and decisions and agreements (or disagreements) and provide copy of record to each conference attendee.

1.4 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit the following:
 - a. Complete layout of all masonry walls showing modular planning and all special shapes to be used in the Work. Show details for each condition encountered in the Work. Provide plan and elevation views drawn at a scale of 1/4-inch equal to 1.0 foot, and details drawn at a scale of 1.5-inch equal to 1.0 foot. Show all items included in unit masonry construction.
 - b. Shop Drawings showing location, extent and accurate configuration and profile of all items shown, specified, and required by this and other Specification Sections included in unit masonry construction.
 - c. Shop Drawing for fabrication, bending, and placement of reinforcing bars. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabricating and placing reinforcing for unit masonry Work.
 - d. Job Mock-up: Shop Drawings showing location, extent, and accurate configuration of all items to be built into the mock-up. Provide elevations drawn at scale of 1.5 inch equal to 1.0 foot.
2. Product Data: Submit the following:
 - a. Copies of manufacturer's specifications and test data for each type of concrete masonry unit specified, including certification that concrete masonry unit complies with Contract Documents. Include instructions for handling, storage, installation and protection of each type of concrete masonry unit.
 - b. Colored Mortar: Technical data on each type of colored mortar, including range of color that can be expected in the Work.
3. Samples: Submit the following:
 - a. Color Sample board, for each type of unit masonry specified, showing standard and custom colors.
 - b. Each type of unit masonry specified in colors selected by ENGINEER. Select each type of unit masonry to show range of color and texture that can be expected in the Work.
 - c. Colored Mortar Samples: Submit complete selection of standard colors and custom colors of mortar for final selection by ENGINEER. Label Samples to indicate type and amount of colorant used.
 - d. ENGINEER's review will be for color and texture only.

B. Informational Submittals:

1. Source Quality Control Submittals: Submit the following:
 - a. Pre-construction laboratory test results, in accordance with ASTM C140.
2. Test and Evaluation Reports

- a. Preconstruction testing results as specified in Paragraph 3.1.B of this Section.
- 3. Qualification Statements:
 - a. Testing laboratory.
 - b. Installer.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Handling of Products:
 - 1. Comply with Section 01 65 00, Product Delivery Requirements.
- B. Storage of Materials:
 - 1. Comply with 01 66 00, Product Storage and Handling Requirements.
 - 2. Maintain temperatures under cover so that masonry products are above 20 degrees F during installation.

1.6 JOB CONDITIONS

- A. Temporary Facilities: Provide supplemental heat sources and equipment as required should CONTRACTOR desire to continue unit masonry Work in cold weather. Pay for fuel for supplemental heat.
- B. Environmental Requirements:
 - 1. Do not perform unit masonry Work when air temperature is below 28 degrees F on a rising temperature, or below 36 degrees F on falling temperatures without providing temporary, heated enclosures, or without providing temporary heating or other precautions to prevent freezing.
 - 2. Do not use frozen products, and do not build upon frozen unit masonry Work.
 - 3. Remove and replace all unit masonry Work damaged by cold.
- C. Protection:
 - 1. Protect unit masonry Work against freezing for at least 48 hours after being placed.
 - a. For Mean Daily Air Temperatures of 40 degrees F to 32 degrees F: Protect unit masonry construction from precipitation for 48 hours after installation.
 - b. For Mean Daily Air Temperatures of 32 degrees F to 25 degrees F: Completely cover unit masonry construction for 48 hours after installation.
 - c. For Mean Daily Temperatures of 25 degrees F to 20 degrees F: Completely cover unit masonry construction with insulating blankets for 48 hours after installation of the masonry.
 - d. For Mean Daily Air Temperatures of 20 degrees F and Below: Maintain unit masonry construction above 32 degrees F for 48 hours by enclosure and supplementary heating.

2. When Work is not in progress, protect partially completed unit masonry construction against rapid heat loss and from water entering the masonry by covering the top of walls with a strong, waterproof, non-staining membrane. Extend the membrane at least two feet down both sides of wall and secure in place using wall cover clamps spaced at intervals of four feet and at each end, and at joints in membrane.
- D. Cold Weather Unit Masonry Construction:
1. Mortar used in unit masonry construction when mean daily temperature is below 40 degrees F shall be Portland cement-lime-sand mortar using high early strength Portland cement.
 2. Clay or shale unit masonry with suctions in excess of 20 grams of water per 30 square inches per minute shall be sprinkled with heated water just prior to installation. Provide water temperature above 70 degrees F when temperature of masonry units is above 32 degrees F. Water temperature shall be above 120 degrees F when temperature of masonry units is below 32 degrees F.
 3. For Air Temperatures of 40 degrees F to 32 degrees F: Heat sand or mixing water to a minimum of 70 degrees F and maximum of 160 degrees F.
 4. For Air Temperatures of 32 degrees F to 25 degrees F: Heat sand and mixing water to a minimum of 70 degrees F and maximum of 160 degrees F.
 5. For Air Temperatures of 25 degrees F to 20 degrees F: Heat sand and mixing water to a minimum of 70 degrees F and maximum of 160 degrees F. Provide heat on both sides of the wall under construction. Employ wind breaks when wind is in excess of 15 mph.
 6. For Air Temperatures of 20 degrees F and Below: Heat sand and mixing water to minimum of 70 degrees F and maximum of 160 degrees F. Provide enclosure and auxiliary heat to maintain air temperature above 32 degrees F in the work area. Temperature of masonry units when laid shall not be less than 20 degrees F.
- E. Hot Weather Unit Masonry Work: Protect unit masonry Work by methods acceptable to ENGINEER from direct exposure to wind and sun when surrounding air temperature is 99 degrees F in the shade with relative humidity less than 50 percent.

PART 2 - PRODUCTS

2.1 MORTAR MATERIALS

- A. Portland Cement: Provide the following for Portland cement-lime mortars:
1. ASTM C150, Type I.
 2. Use ASTM C150, Type III high-early strength, for laying masonry when air temperature is less than 50 degrees F.
 3. Provide nonstaining Portland cement of natural color.
- B. Masonry Cement: Provide the following for masonry cement mortars:

1. ASTM C91 Type S, proportioned to comply with ASTM C270.
 2. Maximum Air Content, ASTM C91: 19 percent.
 3. Non-staining.
- C. Hydrated Lime: ASTM C207 Type S, or lime putty ASTM C5.
- D. Sand Aggregates:
1. ASTM C144, except for joints less than 1/4-inch, use aggregate graded with 100 percent passing the No. 16 sieve.
 2. White Mortar Aggregates: Provide natural white sand or ground white stone for Portland cement-lime mortars.
 3. Colored Mortar Aggregates: Provide ground marble, granite, or other sound stone as required to match the sample approved by ENGINEER for Portland cement-lime mortars.
 4. Fine Aggregate for Grout: Sand, ASTM C404, Size No. 1.
 5. Course Aggregate for Grout: ASTM C404, Size No. 8 or Size No. 89.
- E. Colored Mortar Pigments: Provide the following for Portland cement-lime mortars:
1. Commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black, compounded for use in mortar mixes.
 2. Do not exceed pigment to cement ratios, by weight, of one-to-35 for carbon black, and one-to-seven for other pigments.
 3. Products and Manufacturers: Provide one of the following:
 - a. True-Tone Mortar Colors by Davis Colors, a Subsidiary of Rockwood Pigments, Inc.
 - b. SGS Concentrated Mortar Colors by Solomon Colors.
 - c. Or equal.
 4. ENGINEER will select color of mortar.
- F. Ready-mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified for mortar materials, combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C270 and C387.
- G. Water: Free from injurious amounts of oils, acids, alkalis, or organic matter, and clean, fresh, and potable.

2.2 MORTAR MIXES

- A. General:
1. Anti-freeze Admixture or Agents: Not allowed.
 2. Calcium Chloride: Not allowed.
- B. Mortar for Unit Masonry: Comply with ASTM C270, Table 2, except limit materials to those specified in this Section, do not substitute ASTM C91 masonry cement for ASTM C150 Portland cement without an submittal approval by ENGINEER, and limit cement to lime ratio by volume as follows:

1. Type M.
- C. Grout:
1. Fine Grout:
 - a. Provide the following proportions by volume:
 - 1) Portland Cement: One part.
 - 2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
 - 3) Aggregate Ratio (Measured in a Damp Loose Condition): Sand shall be not less than 2.25 times and not more than three times sum of volumes of cement and lime.
 - b. Mix grout to have a slump of ten inches plus or minus one-inch at placement.
 2. Coarse Grout:
 - a. Provide the following proportions by volume:
 - 1) Portland Cement: One part.
 - 2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
 - 3) Fine Aggregate Ratio (Measured in a Damp Loose Condition): Sand shall be not less than 2.25 times and not more than three times sum of volumes of cement and lime.
 - 4) Coarse Aggregate Ratio: Not less than one and not more than two times sum of volumes of cement and lime.
 - b. Mix grout to have slump of ten inches plus or minus one-inch, at placement.

2.3 CONCRETE MASONRY UNITS

- A. General: Concrete masonry units shall comply with requirements below.
- B. Hollow and Solid Load-bearing Concrete Masonry Units: ASTM C90, with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of concrete mix.
- C. Hollow Non-load-bearing Concrete Masonry Units: ASTM C129 with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of the concrete mix.
- D. Weight:
 1. Provide lightweight concrete masonry units using aggregate complying with ASTM C331 producing dry net weight of not more than 105 pounds per cubic foot.
- E. Size: Manufacturer's standard units with nominal face dimensions of 16 inches long by eight inches high by nominal width dimension shown on Drawings (15-5/8-inches by 7-5/8-inches actual).
- F. Special Shapes: Provide the following:

1. Lintels, bond beams, reinforcing units, and flush-end reinforcing units, interior and exterior corner shapes, solid jambs, sash block, coves, pre-molded control joint blocks, headers, and other special conditions.
 2. Bullnose units for outside vertical corners including doors, windows, louvers and other openings, unless specifically shown by note indicating that this feature is not required.
 3. End blocks at all locations where masonry walls abut concrete, or steel columns to facilitate installation of compressible filler, backer rod and sealant or fire-rated fire stop sealant systems, if required.
- G. Waterproofing Admixture: Manufacture all types of concrete unit masonry, used in construction of exterior walls (including interior wythe of cavity walls) with an integral waterproofing admixture as follows:
1. Material: Cross-linking acrylic polymer.
 2. Proportion: In strict accordance with manufacturer's instructions.
 3. Products and Manufacturers: Provide products of one of the following:
 - a. Dry-Block System by Forrer Industries, a Unit of W. R. Grace & Company Construction Products Division.
 - b. Eucon Blocktite by Euclid Chemical Company.
 - c. Or equal.
- H. Exposed Faces: Provide manufacturer's standard color and texture.
- I. Provide two-core concrete masonry units.
- J. Provide exterior concrete masonry units with polystyrene foam insulation core inserts specified in Section 07 21 05, Building Insulation.
- K. Provide concrete masonry units meeting requirements of the Special Inspections.

2.6 BRICK

- A. Size: Unless otherwise shown or specified, provide standard modular size brick for 3/8-inch mortar joints, 7-5/8 inches long by 2.25 inches high by 3-5/8 inches wide, actual size for exposed vertical brick when laid as a stretcher.
1. Provide special molded shapes where shown and for applications that cannot be sawed from standard brick sizes.
 2. Where brick masonry specified is composed of a mix or range of colors or textures, provide special molded brick masonry shapes in same mix or range of colors or textures as brick masonry specified.
- B. Final color and texture selection within specified color range will be by ENGINEER.
- C. Face Brick to Match Existing: Match custom color, texture and size of existing face brick, and comply with requirements of ASTM C216, Grade SW for type required. If

matching brick of this grade is not available, submit to ENGINEER for approval custom manufactured samples that match existing face brick.

- D. Provide concrete masonry units meeting requirements of the Special Inspections.

2.7 MASONRY ACCESSORIES

- A. Continuous Horizontal Wire Reinforcing and Ties for Masonry: Provide the following unless otherwise shown:

1. General: Welded wire units prefabricated in straight lengths of not less than ten feet, with matching corner "L" and intersection "T" units. Fabricate from cold-drawn steel wire complying with ASTM A82, with deformed continuous 3/16-inch gage side rods and plain 9 gage cross rods, crimped for cavity wall construction, with unit width of 1.5 to two inches less than thickness of wall or partition. All reinforcing and ties shall be hot dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153, Class B-2, unless otherwise specified.
2. For single-wythe masonry, use units fabricated as follows:
 - a. Truss-type fabricated with one horizontal rod beneath each unit masonry shell wall and continuous diagonal cross-rods spaced not more than 16 inches on centers.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) #120 Truss-Mesh 6" and 8" by Hohmann and Barnard, Inc.
 - 2) Series 300 Single Wythe System 6" and 8" by Wire-Bond.
 - 3) DA 3100 Truss 6" and 8" by Dur-O-Wall, a Dayton Superior Company.
 - 4) Or equal.
3. Multi-wythe Masonry Cavity Walls:
 - a. Double-loop wall reinforcing and support system that maintains minimum one-inch in-plane vertical and horizontal adjustability while providing lateral force resistance required for seismic zone shown.
 - b. Welded-closed, upward facing, double vertical loop ties with single pair of side rods in interior wythe, and adjustable, rectangular pintle box ties with parallel overlapping ends, spaced not more than 16 inches on centers. Space side rods for embedment in each face shell wall of back up wythe and extend double-loop ties to allow engagement of rectangular pintle box tie snap-locked to seismic resistance clips and for proper embedment in facing wythe.
 - c. Rigid, polyvinylchloride or 22-gage steel seismic restraint clips, one for each box tie, 3/16 inches high with four horizontal snap-tight connection grooves, one accommodating nine gage wire and three accommodating 3/16-inch diameter wire.
 - d. Continuous, nine gage wire snap-locked into seismic restraint clips for embedment in outer veneer wythe of masonry cavity wall.
 - e. Products and Manufacturers: Provide products of one of the following:

- 1) Lox-All #180 S.I.S Dub'l Loop-Lok Truss 187-A Seismic Interlock System with Loop-Lok Washers by Hohmann & Barnard, Inc.
- 2) DA 3700 S – Seismic Dur-O-Eye; DA 213 QT Lite Duty Seismic Pintel; DA 8706– Pencil Rod; with Shear Lungs by Dur-O-Wal , a Division of Dayton Superior.
- 3) Or equal.

B. Anchoring Devices for Masonry: Provide the following, unless otherwise shown:

1. General: Provide the following:
 - a. Cold rolled steel sheet complying with ASTM A1008, hot-rolled steel sheet and strip complying with ASTM A1011, plates and bars complying with ASTM A36 and cold drawn steel wire complying with ASTM A82, all hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.
 - b. Rectangular, corrugated, one-inch wide ties, fabricated of 12-gage sheet metal, unless otherwise specified.
 - c. Size tie lengths to extend to within one-inch of outside face of outer wythe face shell of opposite face of masonry or to maximum depth of 12 inches and between 1.5 inches to two inches less than width of masonry abutting webs and to a maximum depth of 12 inches abutting flanges of structural supports. Provide wire crimped with a vee-drip for use in cavity wall construction.
 - d. Flexible Anchors: When masonry abuts structural walls or framework provide flexible anchors that allow horizontal and vertical movement of masonry, but provide lateral restraint.
2. Anchorage to Cast-in-place Concrete Walls, Columns and Spandrels: Provide the following for lateral restraint of unit masonry walls abutting cast-in-place concrete members:
 - a. Triangular-shaped ties, fitted with 12-gage dovetail attachments, fabricated of 3/16-inch diameter wire with parallel overlapping ends, spaced not more than 16 inches on centers.
 - b. Rigid, polyvinylchloride or 22-gage steel seismic restraint clips, one for each triangular-shaped tie, 3/16-inches high with four horizontal snap-tight connection grooves, one accommodating nine-gage wire and three accommodating 3/16-inch diameter wire.
 - c. Continuous, nine-gage wire snap-locked into seismic restraint clips for embedment in outer veneer wythe of masonry.
 - d. Products and Manufacturers: Provide products of one of the following:
 - 1) No. 315-BT/Seismicclip/Continuous Wire - Flexible Dovetail Ties, Custom No. 302W(fitted with flexible dovetail attachment) - Column Web Ties and No. 305 - Dovetail Slot by Hohmann & Barnard, Inc.
 - 2) No. 370 Seismic Hook Tab, No. 103 Wire Tie with Dovetail Attachment, No. 100 Dovetail Anchor, with Continuous Wire by Heckmann Building Products.

- 3) DA 720 Series - Seismic Dovetail Triangular Ties with DA 8706 Pencil Rod and DA 100 Dovetail Anchor Slot by Dur-O-Wal, a Dayton Superior Company.
 - 4) Or equal.
 5. Weep Holes and Vents:
 - a. Provide polyvinylchloride ventilator type weeps.
 - b. Product and Manufacturer: Provide products of one of the following:
 - 1) No. 86 Cell Vents for Brick and Block by Heckmann Building Products
 - 2) QV-Quadro-Vent for Brick and Block by Hohmann & Barnard, Inc.
 - 3) No. 3601 Cell Vents for Brick and Block by Wire-Bond.
 - 4) Or equal.
 6. Cavity Fill Mesh:
 - a. Monofilament screen of polypropylene polymers, 1/4-inch mesh hardware cloth.
 - b. Install below all block courses that are to be filled with mortar.
 - c. Products and Manufacturers: Provide products of one of the following:
 - 1) No. MGS-Mortar/Grout Screen by Hohmann & Barnard, Inc.
 - 2) No. 267 Plastic Mesh Wall Tie by Heckmann Building Products.
 - 3) DA 1015 Dur-O-Stop by Dur-O-Wal, a Dayton Superior Company.
 - 4) Or equal.
 7. Compressible Filler: Provide watertight joint filler where unit masonry construction abuts structural framework members, or as shown. Provide the following:
 - a. Polyurethane foam strip saturated with polybutylene waterproofing material which, when installed at a compression ratio of two-to-one, is impermeable to water.
 - b. Resilient to -40 degrees F with 100 percent movement recovery.
 - c. Elongation of 140 percent with a tensile strength of not less than 53 pounds per square inch.
 - d. Products and Manufacturers: Provide products of one of the following:
 - 1) Polytite Standard by Polytite Manufacturing Corporation.
 - 2) Polyseal by Sandell Manufacturing Company, Inc.
 - 3) Or equal.
- C. Miscellaneous Masonry Accessories: Provide the following, where shown:
1. Reinforcing Bars:
 - a. Deformed carbon steel, ASTM A615, Grade 60 for bars No. 3 to No. 18 except as otherwise shown.
 2. Rebar Positioners: Provide the following:
 - a. Nine-gage reinforcing bar positioners that accommodate both horizontal and vertical reinforcing steel.
 - b. Fabricate units as required for the Work.
 - c. Products and Manufacturers: Provide products of one of the following:
 - 1) #RB Series and #RB-Twin Series Rebar Positioners by Hohmann & Barnard, Inc

- 2) Rebar Positioners by Heckmann Building Products.
- 3) Or equal.
- 3. Masonry Control Joint Components: Provide the following:
 - a. Pre-molded Control Joint Strips: Provide complete selection of solid extruded rubber and PVC strips with a Shore A durometer hardness of 80 to 90 complying with ASTM D2240 and D2287, designed to fit standard sash block and maintain lateral stability in masonry wall. Size and configuration shall be as shown.
 - 1) Products and Manufacturers: Provide products of one of the following:
 - a) #RS-8 & RS-Standard - Control Joints by Hohmann & Barnard, Inc.
 - b) #352-12 & 352-10 Control Joints by Heckmann Building Products.
 - c) Or equal.
- 4. Cavity Drainage Material:
 - a. Manufactured of high density polyethylene or nylon strands woven into a 90 percent open mesh
 - 1) Products and Manufacturers: Provide precuts of one of the following:
 - a) Mortar net by Hohmann and Barnard, Inc.
 - b) MortarNet by Heckmann Building Products.
 - c) Or equal.

2.8 SOURCE QUALITY CONTROL

- A. Allowable Tolerances: For concrete masonry units provide the following:
 - 1. Face Dimension: Total variation in finished and installed face dimensions of units shall not exceed 1/16-inch between largest and smallest units in each lot of units of each size.
 - 2. Distortion: Distortion of plane and edges of face of individual units, as installed, from corresponding plane surface and edges of prefaced concrete masonry unit, shall not exceed 1/16-inch.
 - 3. Top and Bottom Surfaces: Ground to provide finish height of 7-5/8 inches plus or minus 1/16-inch.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR and installer shall examine areas and conditions under which unit masonry construction Work will be installed, and notify ENGINEER of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

- B. Preconstruction Testing: Testing agency shall perform tests prior to installation of unit masonry. Special inspections testing procedures are specified in the referenced standards and the Contract Documents.
1. Mortar Test: For each mix required, per ASTM C780.
 2. Grout Test: For each mix required, per ASTM C1019 and ACI 530.1.
 3. Prism Test: For each type of construction required, per ASTM C 1314 and ACI 530.1.
 4. Compressive strength of completed concrete unit masonry walls shall not be less than 1,500 psi as determined by methods specified in ACI 530.1.

3.2 PREPARATION

- A. Measurement of Mortar Materials:
1. Cement and Hydrated Lime: Batched by the bag.
 2. Sand: Batched by volume in suitably calibrated containers, provided proper allowance is made for bulking and consolidation and for weight per cubic foot, of contained moisture.
 3. Proportion of Volumetric Mixtures: One 94-pound sack of Portland cement and one 50-pound sack of hydrated lime constitute nominal one cubic foot.
 4. Shovel measurement: Not allowed.
- B. Mortar Mixing:
1. Type of Mixer: Machine mix in approved mixer in which quantity of water is accurately and uniformly controlled.
 2. While mixer is in operation add approximately three-quarters of required water, half the sand, all the cement, then add remainder of sand.
 3. Allow batch to mix briefly then add water in small quantities until satisfactory workability is obtained.
 4. Mix for at least five minutes after all materials have been added.
 5. Hydrated Lime for Mortar Requiring Lime Content: Use dry-mix method. Turn over materials for each batch together until even color of mixed, dry materials indicates that cementitious material has been thoroughly distributed throughout mass, then add water to obtain required plasticity.
 6. Lime putty, if approved for use, shall be prepared in accordance with ASTM C5.
 7. Mixer drum shall be completely emptied before recharging next batch.
 8. Re-tempering of mortar is not allowed.
- C. Wetting of Masonry Units:
1. Face Brick: Wet brick having ASTM C67 absorption rates in excess of 30 grams per 30 square inches per minute, so that rate of absorption when laid does not exceed this amount.
 - a. Determine absorption by placing 20 drops of water using a medicine dropper inside one-inch diameter circle on typical units. If water is absorbed within 90 seconds, wet brick before laying.

2. Use wetting methods that ensure that each masonry unit is nearly saturated but surface-dry when laid.
 3. Concrete Masonry Units: Except for absorbent units specified to be wetted, lay masonry units dry. Do not wet concrete masonry units.
- D. Cleaning Reinforcement: Before being placed, remove loose rust, mill scale, earth, ice, and other coatings except galvanizing from reinforcement. Do not use reinforcing bars with kinks or bends not shown on Drawings or approved Shop Drawings, or bars with reduced cross-section.

3.3 INSTALLATION, GENERAL

- A. Thickness: Build walls, floors and other unit masonry construction work to thickness shown. Build single-wythe walls to actual thickness of masonry units using units of nominal thickness shown or specified.
- B. Build chases and recesses as shown or required by others. Provide at least eight inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.
- C. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to start of masonry Work. After installing said items, complete unit masonry Work to match Work immediately adjacent to openings.
- D. Cut masonry units using wet cutting, motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full size units without cutting wherever possible.
- E. Match Existing Masonry: Match coursing, pattern bond, color, texture and size of new unit masonry with adjacent, existing masonry.

3.4 LAYING MASONRY WALLS

- A. General:
 1. Mortar Types: Unless otherwise indicated, use mortar as specified and as follows:
 - a. For all Work, use Type M mortar.
 - b. Use coarse grout fill for structural requirements and for grouting reinforcing steel in unit masonry construction Work.
 - c. Do not use mortar that has begun to set or if more than 30 minutes have elapsed since initial mixing. Re-temper mortar during the 30-minute period only as required to restore workability.
 2. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns, and offsets. Avoid using less than half-size units at corners, jambs, and where possible at other locations.

3. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced, and coordinated with other Work.
 4. Pattern Bond Unit Masonry:
 - a. Lay all unit masonry Work visible in the finished Work in running bond with vertical joints in each course centered on units in courses above and below. Avoid using less than full-size units.
 - b. Bond and interlock each course of each wythe at corners.
 - c. Do not use units with less than eight-inch horizontal face dimensions at corners or jambs.
 - d. Interlock alternate courses at corners.
 5. Color of Concrete Unit Masonry:
 - a. Lay all concrete unit masonry of natural color.
- B. Construction Tolerances:
1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 1/4-inch in 10 feet, or 3/8-inch in a story height (20 feet maximum), nor two-inch in 40 feet or more. Except for external corners, expansion joints and other conspicuous lines, do not exceed 1/4-inch in any story or 20 feet maximum, nor two-inch in 40 feet or more.
 2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
 3. Variation of Linear Building Line: For position shown and related portion of columns, walls and partitions, do not exceed two-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
 4. Variation in Cross-sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4-inch nor plus two-inch.
- C. Mortar Bedding and Jointing:
1. Lay solid masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
 2. Lay hollow masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
 - a. Maintain joint widths shown, except for minor variations required to maintain pattern bond alignment. Lay walls with 3/8-inch joints.
 3. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials, except paint, unless otherwise shown.
 4. Tool exposed joints, when mortar is "thumbprint" hard, slightly concave. Rake out mortar in preparation for application of calking or sealants where required.
 5. Concave-tool exterior joints below grade.
 6. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in

position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

- D. Stopping and Resuming Work: Rake back half-unit masonry length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, if required, and remove loose masonry units and mortar prior to laying new masonry.
- E. Built-in Work:
 - 1. As the Work progresses, build in items shown, specified or required by others. Fill cores in one block width solidly with masonry around built-in items.
 - 2. Where built-in items are to be embedded in cores of hollow masonry units, place layer of cavity fill mesh in joint below and rod mortar or grout into core.
- F. Horizontal Joint Reinforcing:
 - 1. Provide continuous horizontal joint reinforcing as specified. Fully embed longitudinal side rods in mortar for their entire length with minimum cover of 5/8-inch on exterior side of walls and 1/2-inch at other locations. Lap reinforcement minimum of six inches at ends of units. Do not bridge masonry control joints with reinforcing.
 - 2. Reinforce all masonry walls with continuous horizontal joint reinforcing unless specifically noted or specified to be omitted.
 - 3. Provide continuity at corners and wall intersections by use of prefabricated “L” and “T” sections. Cut and bend units in accordance with manufacturer’s written instructions.
 - 4. Space continuous horizontal reinforcing as follows:
 - a. Space reinforcing at 16 inches on centers vertically, unless otherwise shown.
 - 5. Reinforce masonry openings greater than 12 inches wide, with horizontal joint reinforcing placed in two horizontal joints approximately eight inches apart, immediately above lintel and immediately below sill. Extend reinforcing minimum of 2.0 feet beyond jambs of opening.
 - 6. In addition to wall reinforcing, provide additional reinforcing at openings as required to comply with the Contract Documents.
- G. Structural Bonding of Multi-wythe Masonry:
 - 1. Use continuous reinforcing embedded in horizontal mortar joints for bond tie between wythes as specified in this Section.
 - 2. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.
 - a. For horizontally reinforced masonry, provide continuity at corners with prefabricated “L” units as specified in this Section, in addition to masonry bonding.
 - 3. Intersecting and Abutting Walls: Unless vertical expansion or masonry control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
 - a. Provide masonry bond in alternate courses.

- b. Provide individual metal ties at not more than 2.0 feet on centers vertically, unless shown at closer spacing.
- c. Provide continuity with horizontal joint reinforcing using prefabricated "T" and "L" units.

H. Non Load-Bearing Interior Partitions and Non Load-Bearing Interior Cavity Wall Wythe:

- 1. Build full height of story to underside of structure above, unless otherwise shown.
- 2. Tie non load bearing partitions and non load bearing interior wythe of cavity walls at top and sides with masonry anchors at terminations. Build in end blocks as shown and specified to facilitate placing compressible filler. Insert compressible filler in all horizontal and vertical joints where non load bearing masonry and non load bearing interior wythe of cavity walls terminate. Insert filler 3/4 inches from both faces of masonry. Use filler four times as thick as the widest part of joint. Thickness of filler shall be minimum of 1.5 times the compressed thickness. Compress filler to less than thickness of joint and insert. At splices, overlap strips by three inches and compress ends to form tight joint. Finish with backer rod and sealant.
- 3. At terminations of non load bearing masonry walls and non load bearing interior wythe of cavity walls requiring fire rating, use firesafing insulation specified in Section 07 21 05, Building Insulation. Build in end blocks to facilitate placing firesafing insulation. Insert insulation in continuous vaportight solid blanket to 3/4 inches from both faces of masonry. Finish with backer rod and sealant.

I. Cavity Walls:

- 1. Determine that bituminous dampproofing is installed (refer to Section 07 11 13, Bituminous Dampproofing).
- 2. Position insulation as shown and per Section 07 21 05, Building Insulation.
- 3. Install cavity drainage material.
- 4. Keep cavity clean of mortar droppings during construction by using continuous horizontal board same width as cavity with lifting wires at each end. Board upward before placing horizontal joint reinforcement. Clean mortar droppings from board. Do not clean into cavity. Joints facing cavity shall be struck flush.
- 5. Tie exterior wythe to masonry back-up with truss and tab-type continuous horizontal wire reinforcing with individual adjustable hook-type box ties spaced no more than 16 inches on centers vertically and 2.0 feet on centers horizontally. Stagger in alternate courses. Refer to Article 2.6 of this Section for type of ties required.
- 6. Tie exterior wythe to concrete back-up with individual dovetail anchors spaced no more than 16 inches on centers vertically and 2.0 feet on centers horizontally. Stagger in alternate courses. Refer to Article 2.6 of this Section for type of anchors required.
- 7. Provide weeps in exterior wythe of cavity wall, in all wall foundation courses and immediately above ledges and flashing, spaced 2.0 feet on centers, unless

closer spacing is shown. Place weeps sequential when laying masonry. Keep weep holes free of mortar and other obstructions.

- J. Structural Reinforced Unit Masonry Construction:
 - 1. Comply with the requirements of ACI 530.1 and applicable codes.
- K. Grouting Structural Reinforced Unit Masonry Construction:
 - 1. Comply with requirements of ACI 530.1 and applicable codes.
- L. Anchoring Masonry Work:
 - 1. Provide anchoring devices of type specified. If not shown or specified, provide standard type for facing and back up involved in compliance with requirements of Laws and Regulations.
 - 2. Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:
 - a. Provide an open space not less than 1/2-inch or more than one-inch in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar and other rigid materials.
 - b. Anchor masonry to cast-in-place concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips and with triangular ties fitted with flexible dovetails for anchorage to cast-in-place concrete.
 - c. Space anchors as shown, but not more than 2.0 feet on center vertically and 3.0 feet on center horizontally.
 - d. Provide end blocks where masonry abuts structural support to facilitate installation of compressible filler, firesafing insulation, backer rod, and sealant.
 - 3. Anchor single wythe masonry veneer to backing with metal ties as follows:
 - a. Anchor veneer to structural members with metal anchors embedded in masonry joints and attached to structure. Provide anchors with flexible tie section, unless otherwise shown.
 - b. Anchor veneer to concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips with triangular ties, fitted with flexible dovetails for anchorage to cast-in-place concrete, snap-locked to seismic clip and attached to structural supports using anchors specified.
 - c. Space anchors as shown, but not more than 2.0 feet on center vertically and 3.0 feet on center horizontally.
- M. Masonry Control and Expansion Joints:
 - 1. Provide vertical control and expansion joints in masonry where shown. Build in related items as unit masonry Work progresses. Rake out mortar in preparation for application of compressible filler, calking and sealants.
 - 2. Masonry Control and Expansion Joints Items: Build in sash block and premolded control joint strips as the Work progresses.

N. Lintels and Bond Beams:

1. Provide masonry lintels and bond beams where openings of 16 inches or more are shown. Provide formed in place masonry lintels and bond beams. Temporarily support formed-in-place lintels and bond beams.
 - a. Unless otherwise shown, provide one horizontal number six deformed reinforcing bar for each 4 inches of wall thickness.
 - b. For hollow masonry unit walls, use specially formed “U”-shaped lintel and bond beam units with reinforcing bars placed as shown, filled with coarse grout as specified.
2. Provide minimum bearing at each jamb of eight inches for all openings.
3. On concrete unit masonry walls where pattern bond remains visually exposed, increase minimum bearing of masonry lintels to maintain joint pattern of wall and install to be indistinguishable from surrounding masonry.

O. Flashing of Masonry Work:

1. Provide concealed flashings in masonry Work as shown. Refer to Section 07620, Flashing and Trim, for type of flashing required. Prepare masonry surfaces smooth and free from projections which might puncture flashing. Place through-wall flashing on bed of mortar and cover with mortar. Seal flashing penetrations with mastic before covering with mortar. Terminate flashing two inches from face of wall, unless otherwise shown. Extend flashing at steel lintels in opening heads and turn down.
 - a. Extend flashings beyond edge of lintels and sills at least 4 inches and turn up edge on sides, to form pan (end dam), to direct moisture to exterior.
 - b. Interlock end joints of deformed metal flashings by overlapping deformations not less than 1.5 inches and seal lap with elastic sealant.
 - c. Install flashings in accordance with manufacturer’s instructions.
2. Install reglets and nailers for flashing and other related work where shown to be built into unit masonry construction Work.

3.5 REPAIR, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings and adjacent Work to provide neat, uniform appearance, properly prepared for application of sealant compounds.
- C. Cleaning Exposed, Unglazed Masonry Surfaces:
 1. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20 square feet as described below. Obtain ENGINEER’s

acceptance of sample cleaning before proceeding to clean remainder of masonry Work.

- a. Dry-clean to remove large particles of mortar using wood paddles and scrapers. Use chisel or wire brush if required.
 - b. Presoak wall by saturating with water and flush off loose mortar and dirt.
 - c. Comply with requirements and recommendations for "Cleaning Clay Products Masonry" of Technical Notes on Brick and Tile Construction by Brick Industry Association for type of masonry and conditions involved in the Work.
 - d. Apply cleaners per manufacturer's instructions.
 - e. Protect other Work from cleaning solutions and cleaning operations.
2. Do not use acid cleaning agent, abrasive tools or powders, or metal cleaning tools or wire brushes, unless specifically recommended in writing by manufacturer.

D. Protection:

1. Protect unit masonry construction Work from deterioration, discoloration or damage during subsequent construction operations.

3.6 FIELD QUALITY CONTROL

- A. CONTRACTOR shall hire independent testing laboratory acceptable to ENGINEER to take samples and conduct tests to evaluate air entrainment, water retention, and compliance of products with Contract Documents, and to determine compressive strength of mortar and grout. Conduct tests in accordance with ASTM C91. Provide tests results to ENGINEER prior to commencement of Work.
- B. After initial test, ENGINEER will require maximum of two additional tests to be conducted at his discretion.
- C. Test and inspect all non-load-bearing concrete unit masonry during construction, meeting requirements of Level 2 Quality Assurance as defined by ACI 530.1.
- D. Masonry walls that do not meet requirements of Special Inspections shall be repaired in manner acceptable to ENGINEER at no expense to OWNER.

3.7 CONSTRUCTION WASTE MANAGEMENT

- A. Construction Waste Management Plan. Refer to Section 01524, Construction Waste Management.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 05 05 33

ANCHOR SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
 - 2. This Section includes all anchor systems required for the Work, but not specified under other Sections.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ACI 318, Building Code Requirements for Structural Concrete.
 - 2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
 - 3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
 - 4. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills And Blanks For Carbide-tipped Masonry Drills.
 - 5. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
 - 6. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 7. ASTM A276, Specification for Stainless Steel Bars and Shapes.
 - 8. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
 - 9. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
 - 10. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - 12. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
 - 13. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

14. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
15. ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
16. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
17. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
20. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
21. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
22. FS A-A-1923A, Concrete Expansion Anchors.
23. FS A-A-1925A, Shield, Expansion (Nail Anchors).
24. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
25. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
26. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
27. ICC-ES AC60, Acceptance Criteria for Anchors in Unreinforced Masonry Elements.
28. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
29. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
30. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
31. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
2. Post-installed Anchor Installer:
 - a. Mechanical Anchors: Installer shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.
 - b. Adhesive Anchors: Installation shall be performed by personnel certified under an applicable certification program. Certification shall include written and performance tests in accordance with the

ACI/CRSI Adhesive Anchors Installer Certification Program, or equivalent. Description of equivalent programs shall be submitted for ENGINEER's approval and acceptance by the building official having jurisdiction.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
 - 2. Product Data:
 - a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
 - b. When required by ENGINEER, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.
 - 3. Samples:
 - a. Representative Samples of anchor systems proposed for use in the Work. Review will be for type and finish only. Compliance with all other requirements is CONTRACTOR's exclusive responsibility.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
 - b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
 - c. For each adhesive anchor installer, submit ACI/CRSI Adhesive Anchor Installer Certification.
 - 2. Manufacturer's Instructions:
 - a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage and Protection:
 - 1. Keep materials dry during delivery and storage.
 - 2. Store adhesive materials within manufacturer's recommended storage temperature range.

3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:

1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
2. Stainless Steel Nuts:
 - a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
 - b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria

1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
 - a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.
 - b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by

the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.

- 1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.
 - 2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.
 - 3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
 - 4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.
 - 5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
 - 6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.
2. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
- a. Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
 - b. Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
 - c. Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of

accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.

- d. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to a design professional retained by CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents.

C. Application:

- 1. Anchor Bolts:
 - a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by ENGINEER.
 - b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
- 2. Concrete Adhesive Anchors:
 - a. Use where adhesive anchors are shown or indicated for installation in concrete.
 - b. Suitable for use where subject to vibration.
 - c. Suitable for use in exterior locations or locations subject to freezing.
 - d. Suitable for use in submerged, intermittently submerged, or buried locations.
 - e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
 - f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
- 3. Concrete Masonry Adhesive Anchors:
 - a. Use where adhesive anchors are shown or indicated for installation in grout-filled or hollow masonry units.
 - b. Suitable for use where subject to vibration.
 - c. Suitable for use in exterior locations or locations subject to freezing.
 - d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
- 4. Concrete Wedge Expansion Anchors:
 - a. Use where expansion anchors are shown or indicated for installation in concrete.
 - b. Do not use where subject to vibration.
 - c. Do not use in exterior locations or locations subject to freezing.
 - d. Do not use in submerged, intermittently submerged, or buried locations.
 - e. Suitable for use in overhead applications.
- 5. Grout-filled Concrete Masonry Wedge Expansion Anchors:

- a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
 - b. Do not use where subject to vibration.
 - c. Do not use in exterior locations or locations subject to freezing.
6. Hollow Concrete Masonry Sleeve Expansion Anchors:
- a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use where subject to vibration.
 - d. Do not use in exterior locations or locations subject to freezing.
7. Drop-in Expansion Anchors:
- a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use where subject to vibration.
 - d. Do not use at submerged, intermittently submerged, or buried locations.
 - e. Do not use in exterior locations or locations subject to freezing.
 - f. Suitable for use in overhead applications.
8. Concrete Undercut Anchors:
- a. Use where undercut anchors are shown or indicated for installation in concrete.
 - b. Suitable for use where subject to vibration.
 - c. Do not use in submerged, intermittently submerged, or buried locations.
 - d. Do not use in exterior locations or locations subject to freezing.
 - e. Suitable for use in overhead applications.
9. Concrete Inserts:
- a. Use only where shown or indicated in the Contract Documents.
 - b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
10. Drive-In Expansion Anchors:
- a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use in overhead applications.
11. For Use in Precast Concrete Planks:

- a. To support piping or conduit six-inch diameter and smaller, use low-profile drop-in anchors, hollow concrete masonry adhesive anchors, or through-bolts.
- b. For piping greater than six-inch diameter, or to support safety-related systems, use through-bolts. Each through-bolt shall consist of threaded rod, nuts, washers, and bearing plate.

2.2 MATERIALS

A. Anchor Bolts:

1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade 36, with heavy hex nuts complying with ASTM A563 Grade A, unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.
2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by ENGINEER. Hooked bolts are unacceptable.
3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.
4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:

1. General:
 - a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
 - a. HIT-RE 500-V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
 - b. HIT-HY 200-A and HIT-HY 200-R Adhesive Anchoring System, by Hilti Fastening Systems, Inc
 - c. SET-XP Adhesive anchoring system, by Simpson Strong-Tie Company, Inc.
 - d. Or equal.
3. Adhesive:
 - a. Adhesive system shall use two-component adhesive mix.
 - b. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance

with ICC-ES AC308, which incorporates the requirements of ACI 355.4-11

- d. Adhesives shall have minimum bond strength and minimum design bond strength in accordance with Table 05 05 33-A:

**TABLE 05 05 33-A:
ADHESIVE BOND STRENGTH ^{1,2}**

Bond Strength (psi)					
Rod Diameter	Uncracked Concrete	Cracked Concrete	Dowel Size	Uncracked Concrete	Cracked Concrete
1/2-inch	1670	880	#4	1500	1080
5/8-inch	1670	750	#5	1460	1090
3/4-inch	1670	665	#6	1415	1015
7/8-inch	1525	610	#7	1370	835
1-inch	1360	595	#8	1330	760
-	-	-	#9	1560	850
1.25-inch	1070	595	#10	1240	475

Table Notes:

1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 130 degrees F and maximum long term concrete temperature of 110 degrees F.

4. Anchor:

- a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

C. Concrete Masonry Adhesive Anchors:

1. General:
 - a. Grout-filled concrete masonry adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
 - b. Hollow concrete masonry adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
 - a. HIT-HY 70 Hybrid Adhesive Anchor System, by Hilti Fastening Systems, Inc.
 - b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
 - c. Or equal.
3. Adhesive:

- a. Adhesive system shall use two-component adhesive mix.
 - b. Hybrid adhesives shall comply with the following:
 - 1) ASTM D695 compressive yield strength greater than 7,200 psi on a seven-day cure.
 - c. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES AC 58 and ICC-ES AC 60.
 - 4. Anchor:
 - a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
 - 5. Mesh Screen Tube (for hollow masonry applications):
 - a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.
- D. Concrete Wedge Expansion Anchors:
- 1. General:
 - a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
 - b. Strong Bolt 2 Wedge Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or equal.
 - 3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4.
 - 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
 - 4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
 - 5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.
 - 6. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.
- E. Grout-filled Masonry Wedge Expansion Anchors:
- 1. General:
 - a. Grout-filled masonry wedge expansion anchors shall each consist of stud, wedge, nut, and washer.
 - 2. Product and Manufacturers: Provide one of the following:
 - a. Kwik-Bolt 3 Expansion Anchors, by Hilti Fastening Systems, Inc.

- b. Wedge-All Wedge Anchors, by Simpson Strong-Tie Company, Inc.
 - c. Or equal.
 - 3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4.
 - 4. Anchors shall be non-bottom bearing type with single-piece steel expansion clip providing 360-degree contact with base material and shall not require oversized holes for installation.
 - 4. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
 - 5. Grout-filled masonry wedge expansion anchors shall have a current ICC Evaluation Service report for use in fully-grouted concrete masonry construction when tested and assessed in accordance with ICC-ES AC01.
- F. Hollow Concrete Masonry Sleeve Expansion Anchors:
 - 1. General:
 - a. Sleeve expansion anchors shall each consist of an externally threaded stud with full length expanding sleeve.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. HLC Sleeve Anchors, by Hilti Fastening Systems, Inc.
 - b. Dynabolt Sleeve Anchors, by ITW Red Head.
 - c. Or equal.
 - 3. Anchors shall comply with physical requirements of FS A-A-1922A. Anchors shall be non-bottom bearing type with single-piece steel expansion sleeve providing 360-degree contact with base material, and shall not require oversized holes for installation.
 - 4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
 - 5. Other Locations: Provide expansion anchors complete with nuts and washers, Type 304 stainless steel, in accordance with ASTM A276 or ASTM A493.
- G. Drop-in Expansion Anchors:
 - 1. General:
 - a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
 - b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or equal.
 - 3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.
- H. Concrete Undercut Anchors:

1. General:
 - a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer. Anchors shall be pre-set type or through-set type, as shown on the Drawings.
2. Products and Manufacturers: Provide one of the following:
 - a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.
 - b. DUC Ductile Undercut Anchor, by USP Structural Connectors.
 - c. Or equal
3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.
5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.
6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

I. Concrete Inserts:

1. Manufacturers: Provide products of one of the following:
 - a. Unistrut Corporation.
 - b. Cooper B-Line, Inc.
 - c. Anvil International, Inc.
 - d. Or equal.
2. Spot Concrete Inserts:
 - a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
3. Continuous Concrete Inserts:
 - a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.

4. Provide inserts with plain finish.
- J. Drive-In Expansion Anchors:
1. General:
 - a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
 2. Products and Manufacturers: Provide one of the following:
 - a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
 - b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or equal.
 3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.
- K. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.
- L. Anti-Seizing Compound:
1. Products and Manufacturers: Provide one of the following:
 - a. Pure Nickel Never-Seez, by Bostik.
 - b. Nickel-Graf, by Anti-Seize Technology.
 - c. Or equal.
 2. Provide pure nickel anti-seizing compound.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Anchor Bolts:
1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
 2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
 3. Protect threads and shank from damage during installation and subsequent construction operations.
 4. Unless otherwise shown or approved by ENGINEER anchor bolts shall comply with Table 05 05 33-B:

**TABLE 05 05 33-B:
SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS ¹**

Bolt Diameter (inch)	F1554 Grade 36				F1554			
	F593 Type 316, Condition A				Grade 55			
	Minimum Embedment (inch)	Minimum Edge Distance and Spacing ² (inch)	Shear ^{3,4} (lb)	Tension ³ (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing ² (inch)	Shear ³ (lb)	Tension ³ (lb)
1/2	6	9	1,262	2,420	8.5	12.75	1,660	3,190
5/8	7.5	11.25	2,010	3,860	10.5	15.75	2,640	5,080
3/4	9	13.5	2,974	5,720	13	19.5	3,910	7,520
7/8	10.5	15.75	4,106	7,890	15	22.5	5,400	10,390
1	12	18	5,386	10,360	17	25.5	7,090	13,450
1 1/8	13.5	20.25	6,787	13,052	19	28.5	8,930	16,580
1 1/4	15	22.5	8,617	16,572	21	31.5	11,340	20,040

Table Notes:

1. Table is based on ACI 318 and ACI 350, Appendix D, $f'_c = 4000$ psi. Table 05 05 33-B is not applicable to anchor bolts embedded in grouted masonry.
2. Critical edge distance and spacing are indicated in the table. Capacity of anchor bolts for other combination of edge distances and spacing shall be evaluated in accordance with ACI 318 and ACI 350, Appendix D.
3. Values for shear and tension listed are not considered to act concurrently. Interaction of tension and shear will be evaluated by ENGINEER in accordance with ACI 318 and ACI 350, Appendix D.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:

1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:

1. Installation conditions shall comply with all requirements of the approved product Evaluation Service Report (ESR), including "Conditions of Use." Comply with manufacturer's written installation instructions and the following.
2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system

manufacturer.

4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
9. Limitations:
 - a. At time of anchor installation, concrete shall have compressive strength (f'_c) of not less than 2,500 psi.
 - b. At time of anchor installation, concrete shall have age of not less than 21 days.
 - c. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
 - d. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
 - e. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

D. Expansion Anchors:

1. Comply with expansion anchor manufacturer's written installation instructions and the following:
2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.

3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
 4. Before installing anchor, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
 5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.
- E. Concrete Undercut Anchors:
1. Comply with undercut anchor manufacturer's written installation instructions and the following.
 2. Protect threads from damage during anchor installation.
 3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
 4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
 5. Insert the anchor by hand until anchor reaches bottom of hole.
 6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
 7. Verify that the setting mark is visible on the threaded rod above the sleeve.
 8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.
- F. Concrete Inserts:
1. Comply with concrete insert manufacturer's installation instructions.
 2. Inserts shall be flush with slab bottom surface.
 3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
 4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.
- G. Anti-Seizing Compound:
1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1.B of this Section.
 2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

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

3.4 FIELD QUALITY CONTROL

A. Site Tests:

1. OWNER will employ testing agency to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
 - a. Testing shall comply with ASTM E488.
 - b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, CONTRACTOR shall pay cost of testing all anchors of the same type installed in the Work. CONTRACTOR shall be responsible for retesting costs.
 - c. ENGINEER will direct which adhesive anchors are to be tested and indicate test load to be used
 - d. Apply test loads with hydraulic ram.
 - e. Displacement of post-installed anchors shall not exceed $D/10$, where D is nominal diameter of anchor being tested.
2. Mechanical Anchors:
 - a. Responsibility:
 - 1) OWNER will employ testing agency to perform field quality control tensile testing of mechanical anchors at the Site.
 - 2) CONTRACTOR shall demonstrate competence in installing mechanical anchors by performing field quality control tests.
 - b. Perform field quality control tests on test anchors at location directed by ENGINEER. Test anchors shall not be part of the finished Work.
 - c. Test not less than one installation of each type of mechanical anchor used in the Work.
 - 1) Load each test anchor to failure.
 - 2) Testing shall comply with ASTM E488.
 - 3) Apply test loads with hydraulic ram.
 - d. Anchors that fail to reach the specified test load shall be considered as not passing the test and shall be re-tested at no additional cost to OWNER.
 - e. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.
3. Correct defective Work by removing and replacing or correcting, as directed by ENGINEER.
4. CONTRACTOR shall pay for all corrections and subsequent testing required to confirm competence in the installation of post-installed mechanical anchors.
5. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.

B. Manufacturer's Services:

1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

+ + END OF SECTION + +

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install structural steel framing, including surface preparation and shop priming.
2. Structural steel framing is the Work defined in AISC 303, Section 2, and as shown or indicated in the Contract Documents. The Work also includes:
 - a. Providing openings in and attachments to structural steel framing to accommodate the Work under this and other Sections, and providing for structural steel framing items such as anchorage devices, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before structural steel framing Work.

C. Related Sections:

1. Section 03 00 05, Concrete.
2. Section 05 05 33, Anchor Systems.
3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 325, Steel Construction Manual.
3. AISC 360, Specification for Structural Steel Buildings.
4. ASME B46.1, Surface Texture (Surface Roughness, Waviness and Lay).
5. ASTM A6/A6M, Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
6. ASTM A36/A36M, Specification for Carbon Structural Steel.
7. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
8. ASTM A108, Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
9. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

10. ASTM A325, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.
11. ASTM A490, Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
12. ASTM A500/A500M, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
14. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
15. ASTM A992/A992M, Specification for Structural Steel Shapes.
16. ASTM E329, for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
17. ASTM F436, Specification for Hardened Steel Washers.
18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F959, Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
20. ASTM F1852, Specification for "Twist off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
21. AWS D1.1/D1.1M, Structural Welding Code-Steel.
22. CMAA 74, Specifications for Top Running & Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist.
23. ISO 2859-1, Sampling Procedures for Inspection by Attributes -- Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-Lot Inspection.
24. ISO 4017, Hexagon Head Screws -- Product Grades A and B.
25. RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Steel Fabricator:
 - a. Structural steel fabricating plant shall possess current certificate from AISC stating that the fabrication facility complies with requirements for certification of "Standard for Steel Building Structures (STD)" of AISC's quality certification program. Fabricating plant shall maintain this certification throughout time of fabrication for this Project.
2. Welders and Welding Processes:
 - a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, Section 5, Qualification.
 - b. Each welder employed on or to be employed for the Work shall possess current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.
3. Surveyor:

- a. Engage a registered professional land surveyor legally qualified to practice in the same jurisdiction as the Site, and experienced in providing surveying services of the kind indicated.
- b. Responsibilities include but are not necessarily limited to:
 - 1) Performing or supervising performance of field survey work to check lines and elevations of concrete and masonry bearing surfaces, and locations of anchorage devices and similar devices, before steel erection proceeds.
 - 2) Notifying CONTRACTOR and ENGINEER in writing when surveyed Work does not comply with the Contract Documents.
 - 3) Submit to CONTRACTOR field survey reports.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing proposed sequence of erection. Shop Drawings shall not be reproductions of Contract Drawings.
 - b. Include complete information for fabrication of the structure's components, including but not limited to location, type, and size of bolts, details of blocks, copes and cuts, connections, camber, holes, member sizes and lengths, and other pertinent data. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld.
 - c. Setting drawings, templates, and directions for installing anchorage devices.
- 2. Product Data:
 - a. Manufacturer's specifications and installation instructions for products listed below.
 - 1) High-strength bolts of each type, including nuts and washers.
 - 2) Welding electrodes and rods.
 - 3) Load indicator bolts and washers.
 - b. Hollow structural section cavity connector manufacturer specifications, load tables, dimension diagrams, and acceptable base material conditions. Clearly indicate allowable strength design safety factors when ultimate load carrying capacities are submitted for approval.
- 3. Samples:
 - a. Representative Samples of hollow section steel cavity connectors proposed for use. Review will be for type and finish only. Compliance with other requirements is CONTRACTOR's responsibility.

B. Informational Submittals: Submit the following:

- 1. Certificates.
 - a. Fabricator's AISC quality certification.

- b. Welders' certifications.
 - c. Certified reports of laboratory tests on previously-manufactured, identical materials, and other data as necessary, to demonstrate compliance with the Contract Documents for the materials listed below:
 - 1) Structural steel of each type, including certified mill reports indicating chemical and physical properties.
 - 2) High-strength bolts of each type, including nuts and washers.
- 2. Supplier Instructions:
 - a. Installation data, handling, and storage instructions.
- 3. Source Quality Control Submittals:
 - a. When performed or when required by ENGINEER, submit results of source quality control testing and inspections performed at the mill or shop.
- 4. Qualifications Statements.
 - a. Land surveyor.
 - b. Testing laboratory.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage:
 - 1. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Do not store materials in or on the building or structure in manner that may cause distortion or damage to structural steel members, building, or supporting structures.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Steel Types:
 - 1. W-Shapes and WT-Shapes: ASTM A992/A992M.
 - 2. S-shapes and Channels: ASTM A572/A572M, Grade 50.
 - 3. Hollow Structural Sections: ASTM A500/A500M, Grade B
 - 4. Angles, Plates, and Bars: ASTM A36/A36M.
 - 5. Steel Pipe: ASTM A53/A53M, Grade B.
- B. Anchorages, Fasteners, and Connectors:
 - 1. Anchorage Devices: Refer to Section 05 05 33, Anchor Systems.
 - 2. Headed Stud Type Shear Connectors: ASTM A108, Grades 1010/1020, complying with AWS D1.1/D1.1M, Section 7.
 - 3. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
 - a. Unless otherwise indicated, fasteners shall be quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM

A325, Type I, nuts complying with ASTM A563C, A563DH or A194/A194M 2H, and hardened washers complying with ASTM F436. Bolts, nuts and washers shall be hot-dip galvanized where shown or indicated.

- c. Tension control bolts, when used, shall comply with ASTM F1852.
- d. Compressible washer-type direct-tension indicators, when used, shall comply with ASTM F959, Type 325.
- 4. Threaded Rod: Provide threaded rods with heavy hexagon nuts, and hardened washers, as follows:
 - a. Interior and Dry Locations: Provide threaded carbon steel rods complying with ASTM A36, with heavy hex nuts complying with ASTM A563A, unless otherwise shown or indicated on the Drawings.
 - b. Exterior, Buried, or Submerged Locations, or When Exposed to Wastewater: Provide stainless steel threaded rods complete with washers complying with ASTM F593, AISI Type 316, Condition A, with ASTM A194/A194M, Grade 8S (nitronic 60) stainless steel nuts. Other AISI types may be used when approved by ENGINEER.

C. Electrodes for Welding: E70XX complying with AWS D1.1/D1.1M.

2.2 FABRICATION

A. Shop Fabrication and Assembly:

1. General:

- a. Fabricate and assemble structural assemblies in the shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC 325, the Contract Documents, and as shown on approved Shop Drawings. Provide camber in structural members as shown or indicated.
- b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize handling of materials for storage and minimize handling at the Site.
- c. Where finishing is required, complete the assembly, including welding of units, before commencing finishing operations. Provide finish surfaces of members exposed-to-view in the completed Work that are free of markings, burrs, and other defects.

B. Connections:

1. Shop Connections:

- a. Unless otherwise shown or indicated, shop connections may be welded or high-strength bolted connections. Welds shall be 3/16-inch minimum.
- b. Where reaction values of beam are not shown or indicated, connections shall be detailed to support one-half the total uniform load capacity tabulated in tables contained in AISC 325 for allowable loads on beams for the associated shape, span, and steel specified for the beam.

- c. Shop-welded connections shall be detailed to eliminate or minimize eccentricity in the connection.
 - d. End-connection angles fastened to webs of beams and girders, and the thickness of angles, size, and extent of fasteners or shop welds, shall comply with tables of "Framed Beam Connections" in AISC 325. Connections shall be two-sided, unless otherwise shown or indicated.
- 2. Field Connections:
 - a. Field connections, unless otherwise shown or indicated, shall be made with high-strength bolts, and shall be bearing-type connections.
 - b. Use field welding only where shown or indicated or where approved by ENGINEER.
- 3. High-Strength Bolted Construction:
 - a. Provide high-strength threaded fasteners in accordance with RCSC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.
 - b. High-strength bolt design shear values shall be as specified in AISC 325 for bolts with threads in the shear plane for bearing type connections, or as specified in this Section for slip-critical connections.
 - c. Bolted connections shown or indicated as "SC" shall comply with slip-critical connection requirements in RCSC Specifications for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
 - 1) Faying surfaces shall have a Class A surface condition.
 - 2) Slip-critical bolts shall be fully pre-tensioned to 70 percent of minimum specified tensile strength of the bolt using one of the following methods:
 - a) Turn of nut with matchmarking.
 - b) Twist-off tension control bolt (ASTM F1852).
 - c) Direct tension indicator washer (ASTM F959).
 - d. Minimum bolt diameter shall be 3/4-inch, unless otherwise shown or indicated.
- 4. Welded Construction: Comply with AWS D1.1/D1.1M for procedures, appearance, and quality of welds, and methods used in correcting defective welding Work.
- 5. Where rigid connections are required by stresses shown or indicated, provide web shear reinforcement and stiffeners in accordance with AISC 360.

C. Bracing:

- 1. Bracing for which stress is not shown or indicated shall have minimum two-bolt connection, or shop-welded connection of equivalent strength.
- 2. Vertical bracing and knee braces connecting to columns shall be on the centerline of columns, unless otherwise shown or indicated.
- 3. Knee braces shall be at 45-degree angle, unless otherwise shown or indicated.
- 4. Gussets shall be not less than 3/8-inch thick, unless otherwise shown or indicated.

- D. Columns: Column shafts shall have finished bearing surface roughness not greater than 500 micro-inch in accordance with ASME B46.1, and ends shall be square within tolerances for milled ends in accordance with ASTM A6/A6M at the base and at splice lines.
- E. Structural Tubing: Properly seal structural tubing to protect internal surfaces.
- F. Monorail:
 - 1. Hoist beam splices shall be smooth and positive, and shall keep the track in perfect alignment horizontally and vertically. Top joint plate shall keep the splice from spreading and develop full strength at the splice. Locate splice as close as possible to track support.
 - 2. Clamps for connecting hoist beams to support beams shall be flush type and suitable for loads shown or indicated.
 - 3. Coordinate monorail Work with equipment and materials under other Sections.
- G. Holes and Appurtenances for Other Work:
 - 1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on the approved Shop Drawings. If large block-outs are required and approved, reinforce the webs to develop specified shears. Provide threaded nuts welded to framing and other specialty items as shown or indicated to receive other work.
 - 2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 FINISHING

- A. Surface Preparation and Shop Priming: Structural steel shall be primed in the shop. For surface preparation and shop priming requirements refer to Section 09 91 00, Painting.

2.4 SOURCE QUALITY CONTROL

- A. Inspection and Testing at the Mill or Shop:
 - 1. Perform fabricator's standard procedures for source quality control, including inspections and testing.
 - 2. Materials and fabrication procedures shall be subject to inspection and tests in mill and shop, conducted by a qualified inspection laboratory. Such inspections and tests do not relieve CONTRACTOR of responsibility for providing the Work in accordance with the Contract Documents.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 ERECTION

- A. General: Comply with AISC 303, AISC 360, and the Contract Documents.
- B. Checking of Lines and Elevations: Before proceeding with structural steel erection, furnish services of a qualified surveyor to check lines and elevations of concrete and masonry bearing surfaces, and locations of anchorage devices and similar devices. Immediately report discrepancies to ENGINEER. Do not proceed with erection until defective Work that will support structural steel is corrected, including agreeing with ENGINEER upon compensating adjustments (if any) to structural steel Work.
- C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy-lines to achieve proper alignment of structures as erection proceeds.
- D. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete the Work. Provide sufficient planking to comply with Laws and Regulations, and provide tightly-planked substantial floor within two stories or 30 feet, whichever is less, below each tier of steel beams on which work is performed.
- E. Anchorage Devices:
 - 1. Provide anchorage devices, including anchor bolts, and other connectors required for securing structural steel to foundations and other in-place construction.
 - 2. Provide templates and other devices necessary for presetting anchorage devices to accurate locations.
 - 3. Refer to Section 05 05 33, Anchor Systems, for anchorage requirements.
- F. Setting Bases and Bearing Plates:
 - 1. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
 - 2. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.

3. Tighten anchorage devices after supported members are positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 4. Place grout between bearing surfaces and bases or plates in accordance with Section 03 60 00, Grouting. Finish exposed surfaces, protect installed materials, and allow to cure in accordance with grout manufacturer's instructions, and as otherwise required.
 5. Do not use leveling plates or wood wedges.
- G. Field Assembly:
1. Set structural frames accurately to the lines and elevations shown and indicated. Align and adjust the various members forming part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 2. Level and plumb individual members of structure within tolerances as specified in AISC 325. For members requiring accurate alignment, provide clip angles, lintels, and other members, with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
 3. Splice members only where shown or indicated.
- H. Erection Bolts: On exposed-to-view, welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.
- I. Connections:
1. Comply with AISC 325 for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
 2. Do not enlarge inadequate holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
- J. Gas Cutting: Do not use gas-cutting torches for correcting fabrication defects in structural framing. Cutting will be allowed only on secondary members that are not under stress, as approved by ENGINEER. Finish gas-cut sections equal to a sheared appearance, when allowed.
- K. Touch-up Painting:
1. Unless otherwise specified, comply with touch-up painting requirements in Section 09 91 00, Painting.
 2. Immediately after erection, clean field welds, bolted connections, and damaged or abraded areas of shop-applied paint. Apply paint to exposed areas with the same paint or coating material applied in the shop. Apply by brush or spray to provide not less than the dry film thickness specified in Section 09 91 00, Painting.

3.3 FIELD QUALITY CONTROL

- A. Site Tests and Inspections: Materials and erection procedures shall be subject to inspection and tests at the Site conducted by qualified inspection laboratory. Such inspections and tests do not relieve CONTRACTOR of responsibility for providing the Work in accordance with the Contract Documents.
1. OWNER will engage independent testing and inspection laboratory to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
 - a. Testing laboratory shall conduct and interpret tests, prepare and state in each report of results whether test specimens comply with the Contract Documents and specifically indicate all deviations.
 - b. High-strength Bolted Connections: Each high-strength bolted connection shall be visually inspected. Inspection shall identify whether the Work complies with Sections 2, 3, and 8 of RCSC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
 - 1) For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning.
 - 2) For connections that are not slip critical and not subject to direct tension, bolt does not need to be inspected for bolt tension, but shall be visually inspected to verify that plies of connected elements are in snug contact.
 - 3) Where bolts or connections are defective, correct defective workmanship, remove and replace, or correct as required defective bolts and connections. CONTRACTOR shall pay for correcting defective Work and tests required to confirm integrity of corrected Work.
 - c. Welds: Each weld shall be visually inspected.
 - 1) Where visually defective welds are evident, further test welds using non-destructive methods. If welds are determined to be acceptable, OWNER will pay for non-destructive testing. When welds are defective, CONTRACTOR shall pay for non-destructive testing.
 - 2) Correct, or remove and replace, defective Work as directed by ENGINEER.
 - 3) CONTRACTOR shall pay for corrections and subsequent tests required to determine weld compliance with the Contract Documents.

++ END OF SECTION ++

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish miscellaneous metal fabrications including surface preparation and shop priming.
2. The Work also includes:
 - a. Providing openings in miscellaneous metal fabrications to accommodate the Work under this and other Sections, and attaching to miscellaneous metal fabrications all items such as sleeves, bands, studs, fasteners, and all items required for which provision is not specifically included under other Sections.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the Work to be installed with, or attached to miscellaneous metal fabrications Work.
2. Hot-dip Galvanizing: Coordinate with steel fabricator detailing for and fabrication of assemblies to be hot-dip galvanized, to minimize distortion during galvanizing process.

C. Related Sections:

1. Section 03 00 05, Concrete.
2. Section 05 05 33, Anchor Systems.
3. Section 05 52 15, Aluminum Handrails and Railings.
4. Section 05 53 36, Aluminum Plank Grating.
5. Section 09 91 00, Painting,

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI A14.3, Ladders – Fixed –Safety Requirements.
2. ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
3. ASTM A36/A36M, Specification for Carbon Structural Steel.
4. ASTM A53/A53M, Specification for Pipe Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
5. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

6. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
8. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
9. ASTM A384/A384M-02 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
10. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
12. ASTM A793, Specification for Rolled Floor Plate, Stainless Steel.
13. ASTM A992/A992M, Specification for Structural Steel Shapes.
14. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
15. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.
16. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. ASTM B632/B632M, Specification for Aluminum-Alloy Rolled Tread Plate.
20. AWS D1.1/D1.1M, Structural Welding Code – Steel.
21. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.
22. AWS D1.6, Structural Welding Code – Stainless Steel.
23. NAAMM, Metal Finishes Manual.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Welding:

- a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, D1.2/D1.2M, or D1.6, as applicable.
- b. When requested by ENGINEER, provide certification that each welder employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Regulatory Requirements: Conform to the following:

1. 29 CFR 1910, Occupational Health and Safety Standards.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Fabrication and erection details for assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for locating and installing miscellaneous metal items and anchorage devices.
 - 2. Product Data:
 - a. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.
 - 3. Samples:
 - a. Sets of representative Samples of materials including nosings, rungs, and other finished products as requested by ENGINEER. ENGINEER's review will be for color, texture, style, and finish only. Compliance with other requirements is exclusive responsibility of CONTRACTOR.
- B. Informational Submittals: Submit the following:
 - 1. Test and Evaluation Reports:
 - a. Mill test report that indicate chemical and physical properties of each type of material, when requested by ENGINEER.
 - 2. Qualifications Statements:
 - a. Copies of welder's certifications, when requested by ENGINEER.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in other construction in ample time to prevent delaying the Work.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Steel:
 - 1. W-Shapes and WT-Shapes: ASTM A992/A992M.
 - 2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
 - 3. Hollow Structural Sections: ASTM A500, Grade B.
 - 4. Angles, Plates, Bars: ASTM A36/A36M.
 - 5. Steel Pipe: ASTM A53/A53M, Grade B.

- B. Aluminum:
 - 1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
 - 2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
 - 3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
 - 4. Aluminum Plates: ASTM B209, Alloy 6061-T6.
- C. Stainless Steel:
 - 1. Plates and Sheets: ASTM A240/A240M, Type 304L or Type 316 stainless steel.
 - 2. Submerged or Intermittently Submerged: Type 316 stainless steel.
 - 3. Non-submerged: Type 304L stainless steel.
- D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 304L or Type 316 Stainless Steel.
- E. Zinc-coated Hardware: ASTM A153/A153M.

2.2 MISCELLANEOUS METAL ITEMS

- A. Shop Assembly:
 - 1. Pre-assemble items in the shop to the greatest extent possible to minimize field-splicing and field-assembly of units at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Aluminum Ladders:
 - 1. Fabricate ladders for locations shown or indicated with dimensions, spacing, details, and anchorages as shown and specified. Comply with OSHA 29 CFR 1910 and ANSI A14.3, except as otherwise shown or specified.
 - a. Unless otherwise shown, provide 1.5-inch diameter continuous side rails, spaced at least 1.5 feet apart.
 - b. Provide extruded square rungs, spaced maximum of 12 inches on centers, with non-slip surface on top of each rung. Adhesive strips for non-slip surfaces are not acceptable.
 - 2. Fit rungs in centerline of side rails, plug weld, and grind smooth on outer rail faces.
 - 3. Support each ladder at top and bottom and at intermediate points spaced not more than five feet on centers.
 - 4. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold ladder clear of wall surface with minimum of seven inches between wall and centerline of rungs.
 - 5. Unless otherwise shown or approved by ENGINEER, extend rails 3.5 feet above top rung, and return rails to wall or structure, unless other secure handholds are provided. If adjacent structure does not extend above top rung, goose-neck extended rails back to structure to provide secure ladder access.
 - 6. Use extruded aluminum conforming to alloy and temper 6061-T6.

C. Aluminum Ladder Safety Cages:

1. Fabricate ladder safety cages from extruded flat bars, assembled by welding.
2. Unless otherwise shown or indicated, provide 1/2-inch by three-inch top, bottom and intermediate hoops spaced not more than five feet on centers; and 3/8-inch by two-inch vertical bars, secured to each hoop.
3. Space vertical bars approximately nine inches on centers.
4. Fasten assembled safety cage to ladder rails and adjacent construction as shown or indicated.
5. Grind welds, sharp edges, and projections smooth.
6. Comply with OSHA 29 CFR 1910 and ANSI A14.3.
7. Use extruded aluminum conforming to alloy and temper 6061-T6.

D. Steel Lintels:

1. Provide loose structural steel lintels for openings and recesses in masonry walls and brick walls as specified or as shown.
2. Weld adjoining members together to form a single unit, where shown or indicated.
3. Provide not less than eight inches bearing at each side of openings, unless otherwise shown.
4. Steel lintels to be installed in exterior walls shall be hot-dip galvanized and finish painted. Other steel lintels shall be painted.
5. Surface preparation and painting shall conform to Section 09 91 00, Painting.
6. Where lintels are not shown on the Drawings, provide lintels as specified in the following table. Provide other lintels where shown and of size indicated on the Drawings.

Clear Span (Max)	Exterior Angle	Interior Angles (typical 8-inch wall)
4.0 feet	3.5 inches by 3.5 inches by 5/16 inches	Two 3.5 inches by 3.5 inches by 5/16 inches
6.0 feet	Four inches by 3.5-inches by 5/16 inches	Two 4 inches by 3.5 inches by 5/16 inches
8.0 feet	Five inches by 3.5 inches by 5/16 inches	Two 5 inches by 3.5 inches by 5/16 inches

E. Shelf Angles:

1. Provide structural steel shelf angles of sizes shown, for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than six inches from ends and not more than 2.0 feet on centers, unless otherwise shown.
 - a. Provide galvanized shelf angles on outdoor construction.
2. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.

F. Aluminum Stair Nosings:

1. Manufacturers: Provide products of one of the following:

- a. Supergrit Type 241BF by Wooster Products, Inc.
 - b. Or equal.
2. Fabricate extruded aluminum nosing of sizes and configurations as shown on the Drawings.
 - a. Unless otherwise shown, provide ribbed abrasive filled type, using black abrasive filler.
3. Provide anchors for embedding in concrete, either integral or applied to treads, as standard with manufacturer.

G. Wheel Guards:

1. Manufacturers: Provide products of one of the following:
 - a. R-4986-DG, by Neenah Foundry Company.
 - b. Or equal.
2. Provide bolted-type wheel guards, 3/4-inch thick minimum, of hollow core gray iron casting, and of size and shape as shown.
3. Provide holes for countersunk anchorage devices and grouting.
4. Anchor wheel guards to concrete or masonry construction in compliance with manufacturer's instructions.
4. Fill cores solidly, using grout as specified in Section 03 00 05, Concrete.
5. Armored-concrete type wheel guards are not acceptable.

H. Fall Prevention System:

1. Provide each ladder with a fall prevention system complying with 29 CFR 1910, ANSI A14.3, and ANSI Z359.1.
2. System shall consist of a carrier rail securely and permanently attached to ladder, over which travels a sleeve to which harness belt can be attached.
3. Products and Manufacturers: Provide products of one of the following:
 - a. Saf-T-Climb by North Safety Products.
 - b. Or equal.
4. Rail:
 - a. Notched at six-inch intervals and constructed of galvanized steel.
 - b. Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.
 - c. For all ladders, include provisions to secure safety sleeve to carrier rail at top of vertical ladder so that sleeve will not slide down rail when safety belt is unsnapped.
 - d. Ladders Below Hatches: Rail for ladder shall extend from bottom of ladder to top of ladder. Provide telescoping safety post as specified in this Article.
 - e. Ladders Not Below Hatches: Rail for ladder shall extend from bottom of ladder to above horizontal landing or roof at top of ladder, Provide removable extension section at top of ladder. Arrange rail to allow climber to land on landing or roof without unsnapping climber's safety harness
5. Accessories: Provide with each ladder the following, all furnished by fall prevention system Supplier:

- a. One safety sleeve compatible for use with the rail. Sleeve shall be cast bronze with five zinc-plated steel roller bearings. Sleeve shall travel smoothly on straight or curved rail.
- b. One safety harness that attaches to sleeve. Harness shall be of woven, high-strength nylon, with padded straps and forged steel buckles and rings. Harness shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.
- c. One shock-adsorbing Y-lanyard no longer than six feet, complying with ANSI Z359.1. Lanyard shall be 5/8-inch diameter nylon rope with double-locking snap hooks at each end.

I. Safety Post:

1. Provide safety post for each fixed access ladder located below an access hatch. Safety post shall be manufactured of high-strength structural material with telescoping tubular section that locks automatically when fully extended.
2. Products and Manufacturers: Provide products of one of the following:
 - a. LadderUP Safety Post by Bilco Company
 - b. Or equal.
3. Use upward and downward movement of post shall be controlled by stainless steel spring balancing mechanism.
4. Safety post shall be hot-dip galvanized steel.

J. Manhole Steps:

1. Provide manhole steps as shown on the Drawings. Conform to requirements of 29 CFR 1910 and ANSI A14.3.
2. Products and Manufacturers: Provide one of the following:
 - a. R-1982-W, manufactured by Neenah Foundry Company.
 - b. Or equal.
3. Vertical separation of steps shall be uniform at maximum of 12 inches on centers. Steps shall project evenly from manhole or chamber walls.
4. Material: Extruded aluminum.

K. Aluminum Bar Screens and Rakes:

1. Provide manually cleaned bar screens as shown on the Drawings. Field verify all dimensions and coordinate with existing conditions prior to fabrication.
2. Fabricate of all aluminum welded construction in accordance with details on the Drawings. Bar screen shall be fabricated from 3"x1/2" bars, spaced 3" center to center. Cross members, angles, hinges, ties, fasteners, frames, bars, bolts, and bearing plates shall be provided to provide the functionality depicted and the structural strength required to adequately support the anticipated loads.
3. Provide a L4x4x3/8 screen seat at the base of the bar screen to be installed in the existing concrete. Screen seat shall be fastened to the existing concrete using 3/8" diameter Type 316 SST adhesive anchors with 4" min. embedment, spaced at 12" on center. Coordinate bar screen with concrete structures within the wet well and mount as required.
4. Use rolled or cold finished aluminum bars and aluminum plate, conforming to alloy and temper 6061 T6.

5. Provide approved aluminum rake of suitable length and spacing to match rack dimensions.
6. Surface preparation and finish painting shall conform to Section 09 91 00, Painting.

L. Bollards:

1. Provide Schedule 80 galvanized steel pipe filled with concrete as shown on the Drawings. Paint as required in accordance with Section 09 91 00, Painting. Unless otherwise shown or specified, finish-paint bollard "Safety Yellow."

M. Miscellaneous Framing and Supports:

1. Provide miscellaneous metal framing and supports that are not part of structural steel framework and are required to complete the Work.
2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings or, if not shown, of required dimensions to receive adjacent grating, plates, tanks, doors, and other work to be retained by the framing.
3. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
4. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
5. Furnish units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units are to be installed after concrete is placed.
 - a. Except as otherwise shown, space anchors, 2.0 feet on centers, and provide units the equivalent of 1.25-inch by 1/4-inch by eight-inch strips.
 - b. Galvanize exterior miscellaneous frames and supports.
 - c. Where shown or indicated, galvanize miscellaneous frames and supports that are not to be installed outdoors.
6. Miscellaneous steel framing and supports shall be hot-dip galvanized and finish-painted, unless otherwise shown or indicated.
7. For railings, refer to Section 05 52 15, Aluminum Handrails and Railing.
8. For grating requirements refer to Section 05 53 36, Aluminum Plank Grating.
9. Surface preparation and painting of galvanized surface shall conform to Section 09 91 00, Painting

N. Aluminum Raised-pattern Floor Plate:

1. Provide raised-pattern floor plate conforming to ASTM B632/B632M and manufacturer's standards. Provide plates of thicknesses shown.
2. Products and Manufacturers: Provide products of one of the following:
 - a. 4-Way Safety Aluminum Plate, by Ryerson Tull Company.
 - b. Raised Pattern Floor Aluminum Plate, by Central Steel and Wire Company.
 - c. Or equal.
3. Provide removable plates at locations and sizes shown. Provide perforated plates where shown.

4. Provide each plate section with four lifting handles as recommended by manufacturer. Lifting handles shall be recessed, drop handle type. Maximum weight of checkered plate or plank section shall be 150 pounds.
 5. Finish: Anodized. Protect finish with factory-applied coating of manufacturer's standard lacquer coating, suitable for service on floor.
- O. Fasteners and Hardware: Provide Type 316 stainless steel fasteners for aluminum fabrications and zinc-coated hardware for galvanized fabrications, unless otherwise shown or specified.
- P. Anchors and Expansion Anchors: Refer to Section 05 05 33, Anchor Systems.

2.3 FINISHING

- A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to miscellaneous metal fabrications in the shop. Conform to surface preparation and shop priming requirements in Section 09 91 00, Painting.
- B. Galvanizing:
1. Galvanizing of fabricated steel items shall comply with ASTM A123/A123M.
 2. Details of fabrication of steel items and assemblies to be hot-dip galvanized shall conform to recommendations of ASTM A384/A384M to minimize the potential for distortion.
- C. Aluminum Finish: Provide an Architectural Class 1 anodized finish, AA-M32C22-A41, clear, as specified in NAAMM Metal Finishes Manual.

2.4 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures complying with the Contract Documents.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which the Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install miscellaneous metal fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.
- B. Anchor securely as shown and as required for the intended use, using concealed anchors where possible.
- C. Fit exposed connections accurately together to form tight, hairline joints. Field-weld steel connections that are not to be exposed joints and cannot be shop-welded because of shipping size limitations. Comply with AWS D1.1/D1.1M, D1.2/D1.2M and D1.6, as applicable to the material being welded. Grind steel joints smooth and touch-up shop paint coat. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- D. Protection of Aluminum from Dissimilar Materials:
 - 1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 91 00, Painting.

+ + END OF SECTION + +

SECTION 05 52 15

ALUMINUM HANDRAILS AND RAILINGS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install aluminum handrail and railing systems. The Work also includes:
 - a. Providing openings in, and attachments to, aluminum handrail and railing systems to accommodate the Work under this and other Specification Sections. Provide all items for aluminum handrails and railings, including anchorages, fasteners, studs, and other items required for which provision for is not specifically included under other Sections.
2. Aluminum handrails and railings Work shall include components and features shown and specified, and all components and features available from specified manufacturers required for providing complete aluminum handrail and railing system in accordance with the Contract Documents.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before aluminum handrails and railings Work.
2. Aluminum handrail and railing locations shall comply with Laws and Regulations.

C. Related Sections:

1. Section 03 60 00, Grouting.
2. Section 05 05 33, Anchor Systems.
3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AA, Aluminum Design Manual.
2. ASTM B26/B26M, Specification for Aluminum-Alloy Sand Castings.
3. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
4. ASTM B136, Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum.
5. ASTM B137, Standard Test Method for Measurement of Coating Mass per Unit Area on Anodically Coated Aluminum.
6. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

7. ASTM B241/B241M, Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
8. ASTM B244, Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments.
9. ASTM B247, Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and rolled Ring Forgings.
10. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
11. ASTM E 935, Standard Test Methods for Permanent Metal Railing Systems and Rails for Buildings.
12. NAAMM/Architectural Metal Products Division (AMP), Pipe Railing Manual.
13. NAAMM/AMP AMP 501 Finishes for Aluminum.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Upon request, manufacturer shall submit document at least five years successful experience in fabricating aluminum handrail and railing systems of scope and type similar to that required.
 - b. Manufacturer shall be capable of providing custom detail drawings for the products required.
2. Professional Engineer:
 - a. CONTRACTOR or handrail and railing manufacturer shall retain a registered professional engineer legally qualified to practice in same state as the Site. Professional engineer shall have at least five years experience designing aluminum handrails and railings.
 - b. Responsibilities include:
 - 1) Reviewing aluminum handrail and railing system performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising preparation of design calculations verifying compliance of aluminum handrail and railing system with requirements of the Contract Documents.
 - 4) Signing and sealing all calculations.
 - 5) Certifying that:
 - a) Design of aluminum handrail and railing system was performed in accordance with performance and design criteria stated in the Contract Documents, and
 - b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
3. Installer:
 - a. Retain a single installer trained and with record of successful experience in installing aluminum handrail and railing systems.

- b. Installer shall have record of successfully installing aluminum handrail and railing systems in accordance with recommendations and requirements of manufacturer, or shall provide evidence of being acceptable to the manufacturer.
- c. Installer shall employ only tradesmen with specific skill and successful experience in the type of Work required.
- d. When requested by ENGINEER, submit name and qualifications of installer with the following information for at least three successful, completed projects:
 - 1) Names and telephone numbers of owner and architect or engineer responsible for each project.
 - 2) Approximate contract cost of the aluminum handrail and railing systems for which installer was responsible.
 - 3) Amount (linear feet) of aluminum handrail and railing installed.

B. Component Supply and Compatibility:

- 1. Obtain all materials furnished under this Section regardless of component manufacturer, from a single aluminum handrail and railing system manufacturer.
- 2. Aluminum handrail and railing system manufacturer shall review and approve or prepare all Shop Drawings and other submittals (except for delegated design submittals, when professional engineer is retained by other than handrail and railing manufacturer) for all components furnished under this Section.
- 3. Components shall be specifically constructed for specified service conditions and shall be integrated into overall assembly by aluminum handrails and railings manufacturer.

C. Regulatory Requirements: Comply with Laws and Regulations including:

- 1. OSHA Part 1910.23, Guarding Floor and Wall Openings and Holes.

D. Certifications:

- 1. Submit certification, signed by authorized officer of manufacturer and notarized, stating that handrail and railing systems comply with the design prepared by the professional engineer.
- 2. Submit certification, signed by authorized officer of CONTRACTOR and notarized, stating that all components and fittings are furnished by the same manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Drawings for fabrication and installation of aluminum handrail and railing systems with sizes of members, pipe wall thickness, information on components, and anchorage devices. Show all anchorages. Provide details drawn at scale of 1.5-inch equal to one foot.
 - b. Indicate required location of posts.

- c. Indicate locations and details of all expansion joints, if any.
 - d. Indicate locations and details of gaps across seismic joints, if any.
 - e. Profile drawings of aluminum handrail and railing system components.
 - f. Custom detail drawings. Details of forming, jointing, sections, connections, internal supports, trim and accessories. Provide details drawn at scale of 1.5-inch equal to one foot.
2. Product Data:
- a. Manufacturer's specifications, standard detail drawings, and installation instructions for aluminum handrail and railing systems.
 - b. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by ENGINEER.
3. Delegated Design Submittals:
- a. Design Data:
 - 1) Design computations or complete structural analysis of handrail and railing systems, signed and sealed by professional engineer. Professional engineer's seal shall be clearly legible, including state of registration, registration number, and name on seal.
 - 2) Certification by professional engineer that professional engineer has performed design of aluminum handrail and railing systems in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to all local, state, and federal Laws and Regulations, and to prevailing standards of practice.
4. Samples:
- a. Full-size Sample, two feet long, of assembled railing system at post and rail intersections. Sample shall have all associated components including typical connections, mounted toeboard and sleeve, and handrail at wall return, complete with mounting brackets, all with specified controlled uniform metal finish.
 - b. Color Samples: Maximum range of clear anodized aluminum that shall appear in finished Work. Prepare range Samples, to show highest level of color control feasible for actual handrail and railing systems, as determined by licensor of finishing process specified, on actual extrusions and castings of the Work.
 - c. ENGINEER will review Samples for finish, color, joint tolerances, workmanship, and general component assembly only. Compliance with other requirements is the responsibility of the CONTRACTOR.
5. Test Procedure: Submit detailed description of proposed shop testing procedures. Do not perform shop testing until ENGINEER approves shop test procedure:

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Certification on source of supply, as specified in Article 1.3 of this Section.
 - b. Manufacturer certification specified in Article 1.3 of this Section.
- 2. Source Quality Control Submittals:

- a. Manufacturer's load testing report in accordance with ASTM E935 for completed aluminum handrail and railing systems, demonstrating compliance with applicable requirements of building codes, safety codes, and other Laws and Regulations.
- 3. Qualifications Statements: Submit qualifications for the following:
 - a. Manufacturer, when requested by ENGINEER.
 - b. Professional engineer.
 - c. Installer, when requested by ENGINEER. Qualifications statement shall include record of experience with references specified.
- C. Closeout Submittals: Submit the following:
 - 1. Maintenance Manuals: Furnish detailed maintenance manuals that include the following:
 - a. Product name and number.
 - b. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods and precautions in use of products that may be detrimental to finish when improperly applied.
 - c. Handrail and railings systems manufacturer's current catalog including individual parts.
 - d. Maintenance manuals shall be in accordance with Section 01 78 23, Operations and Maintenance Data.
 - 2. Guarantee: Provide in maintenance manual the guarantee specified.
- D. Maintenance Material Submittals: Submit the following:
 - 1. Extra Stock Materials:
 - a. After completing installation, deliver to OWNER two percent of actual quantity of each handrail and railing system component used in the Work.
 - b. Label each piece or sealed container with name and product number.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage and Protection:
 - 1. Keep products off ground using pallets, platforms, or other supports. Protect products from corrosion and deterioration.
- B. Handling of Products:
 - 1. Do not subject handrail and railing products to bending or stress.
 - 2. Do not damage edges or handle products in a manner that will cause scratches, warping, or dents.
 - 3. Protect handrails and railings by paper or coating as acceptable to handrail and railing manufacturer, against scratching, splashes of mortar, paint, and other marring during transportation, handling, and erection. Protect until completion of adjacent work.

1.6 GUARANTEE

- A. Guarantee: Manufacturer shall provide written guarantee of availability of replacement parts and components for period of at least five years after completion of the Project.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. System Description: Aluminum handrail and railing system shall consist of equally spaced horizontal rails with totally concealed mechanical fasteners, internally threaded tubular rivets and components fastened to posts spaced no more than five feet on centers and system of handrails supported from adjacent construction by mounting brackets spaced at no more than five feet on centers.
- B. Design Criteria and Performance Criteria:
 - 1. Design, fabricate, and install aluminum handrail and railing systems to withstand the most critical effects resulting from the following loads (loads listed below do not act concurrently):
 - a. Uniform Load: 50 pounds per foot, applied at top in any direction.
 - b. Concentrated Load: 200 pounds single load, applied at any point along the top in any direction.
 - c. Components: Intermediate rails (all rails except the handrail), balusters, and panel fillers, if any, shall withstand horizontally-applied normal load of 50 pounds on an area equal to one square foot, including openings and space between rails. Reactions due to this loading are not required to be superimposed to loading specified for main supporting members of handrails and railings.
 - d. Comply with AA Aluminum Design Manual for determining allowable stresses and safety factors for aluminum structural components.
 - e. Limit deflection in each single span of railing and handrail to 1.5-inch maximum, and to 1/4-inch maximum on railing posts. Applied loads shall not produce permanent deflection in the completed Work when loads are removed.
 - 2. Thermal Control: Provide adequate expansion within fabricated systems that allows for thermal expansion and contraction caused by material temperature change of 140 degrees F to -20 degrees F without warp or bow of system components. Distance between expansion joints shall be based on providing 1/4-inch wide joint at 70 degrees F, which accommodates movement of 150 percent of calculated amount of movement for specified temperature range.
 - 3. Where handrail and railing systems cross expansion joints in the building or structure, provide expansion joints in handrail and railings systems.
 - 4. For posts located at or near end of runs as shown, uniformly space intermediate posts as required to conform to loading and deflection criteria specified, at intervals no greater than maximum post spacing specified. Where posts are

shown for handrails along both sides of walkways and other similar locations, locate posts opposite each other; do not stagger post locations.

2.2 MANUFACTURERS

- A. Products and Manufacturers: Provide one of the following:
 - 1. Custom Fabricated Connectorail System, by Julius Blum & Company, Inc.
 - 2. Custom Fabricated Series 500 Non-Welded Aluminum Pipe Aluminum handrails and railing systems, by Superior Aluminum Products, Inc.
 - 3. Or equal.

2.3 MATERIALS

- A. Extruded Aluminum Architectural and Ornamental Shapes: ASTM B221, Alloy 6063-T52.
- B. Aluminum Forgings: ASTM B247.
- C. Extruded or Drawn Aluminum Pipe and Tube:
 - 1. ASTM B429 or ASTM B241/B241M, Alloy 6063-T5, 6063-T52, or 6063-T832 as required by loadings, deflections, and post spacing specified.
 - 2. Provide Schedule 40 pipe, minimum, unless conditions of detail and fabrication require extra-heavy pipe to comply with Specifications. Rails and posts shall have minimum outside diameter of 1.90 inches.
- D. Reinforcing Bars: Solid, circular profile, two feet long, 6061-T6 aluminum reinforcing bars with same outside diameter as inside diameter of post.
- E. Anchors and Fastenings:
 - 1. For anchors and fasteners, use Type 316 stainless steel; minimum 3/8-inch diameter.
 - 2. Provide minimum of four bolt fasteners per post where surface-mounted posts are shown. Components shall be in accordance with manufacturer's recommendations and as approved or accepted (as applicable) by ENGINEER on submittals.
 - 3. Anchors: In accordance with Section 05 05 33, Anchor Systems.
- F. Castings:
 - 1. Provide high-strength aluminum alloy brackets, flanges, and fittings suitable for anodizing as specified.
 - 2. Aluminum alloy sand castings: ASTM B26/B26M.
- G. Connector Sleeves: Schedule 40, five-inch long by 1.610-inch diameter.
- H. Sockets: Provide six-inch deep by 2.5-inch outside diameter aluminum sockets with 3.5-inch wide socket cover on bottom of each socket and on top and bottom of removable post sockets.

- I. Custom Cover Flanges: 1/4-inch high by four-inch diameter, aluminum.
- J. Adhesive: Two-part waterproof epoxy-type as recommended by handrail and railing systems manufacturer.
- K. Non-shrink Grout: Comply with Section 03 60 00, Grouting.
- L. Toeboards:
 - 1. Provide extruded Alloy 6063-T5 or T52 aluminum alloy toeboards, unless railing is mounted on curbs or other construction of sufficient height and type to comply with OSHA 1910.23. Bars or plates are not acceptable.
 - 2. Unless otherwise specified, toeboards shall comply with OSHA 1910.23, Section (e).
- M. System Components and Miscellaneous Accessories: Provide complete selection of manufacturer's standard and custom aluminum handrail and railing systems components and miscellaneous accessories required. Show type and location of all such items on Shop Drawings and other submittals as applicable.

2.4 FABRICATION

- A. General: Unless otherwise shown or specified, provide typical non-welded construction details and fabrication techniques recommended in NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501.
- B. Fabricate handrail and railing systems true to line and level, with accurate angles surfaces and straight edges. Fabricate corners without using fittings. Provide bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces, or use prefabricated bends. Provide not less than four-inch outside radius.
- C. Remove burrs from exposed edges.
- D. Close aluminum pipe ends by using prefabricated fittings.
- E. Weep Holes:
 - 1. Fabricate joints that will be exposed to weather to exclude water.
 - 2. Provide 15/64-inch diameter weep holes at lowest possible point on each post in handrail and railing systems.
 - 3. Provide pressure relief holes at closed ends of handrail and railing systems.
- F. Toeboards:
 - 1. Provide manufacturer's standard toeboard, that accommodates movement caused by thermal change specified without warping or bowing toeboards.

2. Provide manufacturer's standard toeboard, which accommodates storage for removable socket covers.
 3. Coordinate and cope toeboard as required to accommodate cover flanges at posts.
 4. Toeboards shall follow curvature of railing. Where railing is shown to have curved contours at corners, or other locations, toeboard shall likewise be curved to follow line of railing system.
- G. Reinforcing Bars: Provide reinforcing bar friction-fitted at each post in railing system. Extend reinforcing bars of tubes six inches into cast-in-place sleeves or other types of supporting brackets.
- H. Mechanically Fitted Component Pipe Handrail and Railing System:
1. Use non-welded pipe handrail and railing system with posts, top and intermediate rail(s), and flush joints.
 2. Provide top and one intermediate horizontal rail(s), equally spaced.
 3. Do not use blind rivets, pop rivets, or other exposed fastening devices in the Work under this Section. Fasteners used for side-mounting fascia flanges where shown or specified may be exposed in the Work. Provide internal threaded aluminum rivets, stainless steel through-bolts with lock nuts, stainless steel sheet metal screws with lock washers, and epoxy adhesive for fastening components of the Work.

2.5 FINISHES

- A. General:
1. Prepare surfaces for finishing in accordance with recommendation of aluminum producer and the aluminum finisher or processor.
 2. Adjust and control direction of mechanical finishes specified to achieve best overall visual effect in the Work.
 3. Color and Texture Tolerance: Provide uniform color and continuous mechanical texture for aluminum components. ENGINEER reserves the right to reject aluminum materials because of color or texture variations that are visually objectionable, but only where variation exceed range of variations established by manufacturer prior to fabrication, by means of range of Samples approved by ENGINEER.
 4. Anodize aluminum components.
- B. Finish:
1. Mechanically finish aluminum by wheel or belt polishing with aluminum oxide grit of 180 to 220 size, using peripheral wheel speed of 6,000 feet per minute; AA Designation - M32 Medium Satin Directional Texture.
 2. Hand-Rubbed Finish: Where required to complete the Work and provide uniform, continuous texture, provide hand-rubbed finish to match medium satin directional texture specified to even out and blend satin finishes produced by other means.

- C. Cleaning:
1. Provide non-etching chemical cleaning by immersing aluminum in inhibited chemical solution, as recommended by coating applicator, to remove lard oil, fats, mineral grease, and other contamination detrimental to providing specified finishes.
 2. Clean and rinse with water between steps as recommended by aluminum manufacturer.
- D. Exposed Aluminum Anodic Coating: Provide anodic coatings as specified that do not depend on dyes, organic or inorganic pigments, or impregnation processes to obtain color. Apply coatings using only the alloy, temperature, current density, and acid electrolytes to obtain specified colors in compliance with designation system and requirements of NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501. Comply with the following:
1. Provide Architectural Class I high density anodic treatment by immersing the components in tank containing solution of 15 percent sulfuric acid at 70 degrees F with 12 amperes per square foot of direct current for minimum of sixty minutes; AA Designation A41 Clear.
 2. Physical Properties:
 - a. Anodic Coating Thickness, ASTM B244: Minimum of 0.7-mils thick.
 - b. Anodic Coating Weight, ASTM B137: Minimum of 32 mg/sq. in.
 - c. Resistance to Staining, ASTM B136: No stain after five minutes dye solution exposure.
 - d. Salt Spray, ASTM B117: 30,000 hours exposure with no corrosion or shade change.
 3. Seal finished anodized coatings using deionized boiling water to seal pores and prevent further absorption.
 4. Products and Manufacturers: Provide one of the following:
 - a. Alumilite 215 Clear by Aluminum Company of America, Inc.
 - b. Or equal.

2.6 SOURCE QUALITY CONTROL

- A. Allowable Tolerances:
1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
 - a. Spacing: Plus-or-minus 3/8-inch.
 - b. Alignment: Plus-or-minus 1/4-inch.
 - c. Plumbness: Plus-or-minus 1/8-inch.
 2. Minimum Handrails and Railings Systems Plumb Criteria:
 - a. Limit variation of completed handrail and railing system alignment to 1/4-inch in 12 feet with posts set plumb to within 1/16-inch in 3.0 feet.
 - b. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12.0 feet.
 3. Provide "pencil-line" thin butt joints.

B. Factory Testing:

1. Perform load test on completed handrail and railing systems. Extent of handrail and railing systems to be factory-tested shall be as shown and specified.
2. Load test completed handrail and railing systems in accordance with requirements of ASTM E935. Provide written report to ENGINEER identifying and documenting testing methods used, magnitude and location of loads superimposed, and results of such tests on actual completed handrail and railing systems, including all anchors and fasteners to be used in the Work. Testing setup shall simulate actual conditions of installation to be used in the Work.
3. Do not ship products from factory until ENGINEER accepts load testing report.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Verify to ENGINEER the gage of aluminum pipe railing posts and rails brought to the Site by actual measurement of on-Site material in presence of ENGINEER.

3.2 INSTALLATION

A. General:

1. Do not erect components that are scarred, dented, chipped, discolored, otherwise damaged, or defaced. Remove from Site railing and handrail system components that have holes, cuts, gouges, deep scratches, or dents of any kind. Repairs to correct such Work will not be accepted. Remove and replace with new material.
2. Comply with installation and anchorage recommendations of NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501 in addition to requirements specified and approved or accepted (as applicable) submittals.

B. Fastening to In-Place Construction:

1. Remove protective plastic immediately before installing.
2. Adjust handrails and railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building or structure as follows:
 - a. Anchor posts in concrete by providing sockets set and anchored into concrete floor slab. Provide closure secured to bottom of sleeve. Before installing posts, remove debris and water from sleeves. Verify that reinforcing bars or tubes have been inserted into posts before installation.

Do not install posts without reinforcing bar. For all non-removable handrail and railing systems sections, after posts have been inserted into sockets, fill annular space between posts and sockets solid with grout as specified in Section 03 60 00, Grouting. Crown the grout and slope grout to drain away from posts.

- b. Anchor posts to stair stringers with stringer or support flanges, angle type or floor type as required by conditions, shop-connected to posts and bolted to steel supporting members. Flanges shall be as recommended by manufacturer. Verify that reinforcing bars are inserted into posts before installation. Do not install posts without reinforcing bar.
 - c. Side-mount posts by fastening them securely in brackets attached to steel or concrete fascia as shown and in accordance with approved or accepted (as applicable) submittals.
 - d. Provide removable railing sections where shown. Provide removable railing system posts with friction-fitted reinforcing bar in each post. Provide sockets with socket covers stored in extruded toeboard. Provide aluminum pipe collars for all removable posts. Accurately locate sleeves to match post spacing.
 - e. Provide posts set in concrete with an aluminum floor cover flange.
3. Use devices and fasteners recommended by handrail and railing systems manufacturer and as shown on approved or accepted (as applicable) submittals.

C. Cutting, Fitting, and Placement:

1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels.
2. Fit exposed connections accurately together to form tight hairline joints. Do not cut or abrade surfaces of units that have been finished after fabrication, and are intended for field connections.
3. Make permanent field splice connections using manufacturer's recommended epoxy adhesive and five-inch minimum length connector sleeves. Tight press-fit field splice connectors and install in accordance with manufacturer's written instructions. Follow epoxy manufacturer's recommendations for requirements of installation and conditions of use.
4. Make splices as near as possible to posts, but not exceeding 12 inches from nearest post.
5. Field welding is not allowed. Make splices using pipe splice lock employing a single allen screw to lock joint.
6. Secure handrails to walls with wall brackets and end fittings as shown. Drill wall plate portion of the bracket to receive one bolt, unless otherwise shown for concealed anchorage. Locate brackets as shown or, if not shown, at not more than five feet on centers. Provide flush type wall return fittings with same projection shown for wall brackets. Secure wall brackets and wall return fittings to building or structure. Refer to Section 05 05 33, Anchor Systems.
7. Securely fasten toeboards in place with not more than 1/4-inch clearance above floor level.

8. Drill one 15/64-inch diameter weep hole not more than 1/4-inch above top of location of solid reinforcing bar or tube in each post.
- D. Fastening to Existing Construction:
1. Provide heavy-duty floor flange and anchorage devices and fasteners where necessary for securing handrail and railing systems components to existing construction; including stainless steel threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as required. Refer to Section 05 05 33, Anchor Systems.
 2. Use devices and fasteners recommended by handrail and railing systems manufacturer and as shown on approved or accepted (as applicable) submittals.
- E. Expansion Joints:
1. Provide slip joint with internal sleeve extending not less than two inches beyond joint on each side.
 2. Construct expansion joints as for field splices, except fasten internal sleeve securely to one side of rail only.
 3. Locate joints within six inches of posts.
- F. Seismic Joints:
1. Discontinue handrails and railings on each side of seismic joints where handrails and railings cross over seismic joints in structure.
 2. Comply with details shown on the Drawings.
- G. Protection from Dissimilar Materials:
1. Coat aluminum surfaces in contact with dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 91 00, Painting.
 2. Do not extend coating beyond contact surfaces. Remove coating where exposed-to-view in the finished Work.

3.3 CLEANING AND REPAIRING

- A. Cleaning:
1. Clean exposed surfaces of handrail and railing systems after completion of installation. Comply with recommendations of both handrail and railing system manufacturer and finish manufacturer. Do not use abrasives or unacceptable solvent cleaners. Test cleaning techniques on an unused section of railing before employing cleaning technique.
 2. Remove stains, dirt, grease, and other substances by washing handrails and railings systems thoroughly using clean water and soap; rinse with clean water.
 3. Do not use acid solution, steel wool, or other harsh abrasives.
 4. If stain remains after washing, remove defective sections and replace with new material complying with this Section.
- B. Handrails and railings shall be free of dents, burrs, scratches, holes, and other blemishes. Replace damaged or otherwise defective Work with new material that complies with this Section at no additional cost to OWNER.

- C. Prior to Substantial Completion, replace adjacent work marred by the Work of this Section.

+ + END OF SECTION + +

SECTION 05 53 36

ALUMINUM PLANK GRATING

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install aluminum plank grating.
 - 2. The Work includes:
 - a. Providing aluminum plank grating, frames, and appurtenances.
 - b. Providing openings in aluminum plank grating to accommodate the Work under this and other Sections and attaching to aluminum plank grating all items such as sleeves, bands, studs, fasteners, and items required for which provision is not specifically included under other Sections.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before aluminum plank grating Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. AA Aluminum Design Manual.
 - 2. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 3. NAAMM MBG 531, Metal Bar Grating Manual.
 - 4. NAAMM MBG 533, Welding Specifications for Fabrication of Steel, Aluminum and Stainless Steel Bar Grating.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Shall have at least five years experience manufacturing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.
- B. Component Supply and Compatibility:

1. Obtain all products and materials included in this Section regardless of component manufacturer from a single aluminum plank grating manufacturer.
2. Aluminum plank grating manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all products and materials furnished under this Section.
3. Components shall be suitable for the specified service conditions and be integrated into overall assembly by aluminum plank grating manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Fabrication and erection of all Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.
 - b. Setting drawings and templates for location and installation of anchorage devices.
2. Product Data:
 - a. Manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.
3. Samples:
 - a. Representative Samples of aluminum plank grating, appurtenances, and other finished products requested by ENGINEER.
 - b. ENGINEER'S review will be for type and finish only. Compliance with other requirements is exclusive responsibility of CONTRACTOR.

1.5 DELIVERY, STORAGE AND HANDLING

A. Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices to be embedded in cast-in-place concrete in ample time to prevent delaying the Work.
2. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:

1. Protect materials from corrosion and deterioration.
2. Do not store materials in contact with concrete or other materials that might cause corrosion, staining, scratching, or damage materials or finish.
3. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Aluminum Plank Grating: Provide aluminum plank grating complying with the following:

1. Grating Design Loads: Uniform live load shall be as shown or indicated in the Contract Documents. Where live load is not shown or indicated, uniform live and concentrated loads shall be as indicated in the table below, whichever results in the greater design stresses.

	Live Load	Concentrated Load
a.	100 psf	500 lbs. per foot of grating width at center of span

2. Maximum Clear Span Deflection for Uniform Live Loads: 1/120 of span, but not more than 1/4-inch.
3. Maximum Fiber Stress: 12,000 psi.
4. Do not install aluminum plank grating in areas subject to vehicular traffic.
5. Rectangular banding bars shall be of same height and material as bearing bars.
6. Comply with requirements of AA Aluminum Design Manual and NAAMM MBG 531.

2.2 MANUFACTURERS

- A. Aluminum Plank Grating, Products and Manufacturers: Provide one of the following:

1. Ohio Gratings, Heavy Duty, Unpunched.
2. IKG Borden, Heavy Duty, Unpunched.
3. Or equal.

2.3 MATERIALS

- A. Aluminum alloy 6061-T6 or 6063-T6, conforming to ASTM B221.
- B. Frames: Aluminum alloy 6061-T6 or alloy 6063-T6, complying with ASTM B221.
- C. Stud anchors welded to steel supports and other fasteners shall be Type 316 stainless steel.

2.4 FABRICATION

- A. Use materials of minimum depth and thickness specified and required to comply with performance criteria in the Contract Documents.
- B. Provide removable plank grating complying with the following, unless otherwise shown or indicated:
1. Aluminum Plank Grating:
 - a. Comprised of smooth-sided, six-inch wide aluminum extrusions with integral I-beam sections at 1.2 inches on centers. Sections shall be banded together to form standard panel widths.

- b. Minimum Depth: 1.5 inches.
 - c. Top surface shall be unpunched, and have continuous raised longitudinal ridges for skid resistance.
 - d. Finish: Mill.
- C. Provide cutouts in aluminum plank grating for passage of piping, electrical conduit, valve stems, columns, ducts, and similar work. Openings in and edges of gratings sections shall be banded with banding bars. Weld bands to intersecting members.
- D. Aluminum plank gratings shall be accurately fabricated, free from warps, twists, and other defects that would affect plank grating appearance and plank grating serviceability.
- E. Welding shall comply with requirements of NAAMM MBG 533. Welds shall be ground smooth at top surfaces and bearing surfaces.
- F. Size each section of aluminum plank grating to weigh maximum of 100 pounds, unless otherwise indicated in the Contract Documents.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Check all dimensions at the Site after piping and equipment are in place and determine exact locations of openings and cutouts.

3.2 INSTALLATION

- A. Fastening to In-Place Construction:
 - 1. Use plank clips to secure aluminum plank grating to supporting members, as recommended by manufacturer.
- B. Cutting, Fitting, and Placing:
 - 1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true, and free of rack. Do not use wedges or shimming devices.
 - 2. Divide panels into sections only to extent required for installation where aluminum plank grating is to be installed around previously-installed piping, electrical conduit, ducts, structural members, or similar protrusions. Use standard panel widths when possible.

- C. Weld Type 316 stainless steel stud bolts to receive plank lugs to supporting steel members. Drill holes for machine bolts when supports are aluminum.
- D. Aluminum plank gratings in concrete floors shall be removable and arranged in sizes to be readily lifted. Provide aluminum plank gratings in concrete with aluminum angle frames having mitered corners and welded joints. Grind exposed joints smooth. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected for flush fit.
- E. Tops of aluminum plank gratings shall be set flush with surrounding construction.
- F. Aluminum plank gratings shall be set with full and uniform end bearing on frames to preclude rocking movement; do not use wedges or similar shimming devices.
- G. Protection of Aluminum from Dissimilar Materials: Coat aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel, or other metals, in accordance with Section 09 91 00, Painting.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, material, tools, equipment, and incidentals as shown, specified, and required to furnish and install all miscellaneous rough carpentry Work.
2. The Work also includes:
 - a. Providing openings in miscellaneous rough carpentry to accommodate the Work under this and other Sections and building into miscellaneous rough carpentry items such as sleeves, anchorages, inserts and other items to be embedded in or penetrating miscellaneous rough carpentry for which placement is not specifically provided under other Sections.
3. Extent of miscellaneous rough carpentry is not shown or indicated.
4. Types of materials required include:
 - a. Miscellaneous blocking, furring strips, and other miscellaneous wood framing.
 - b. Lumber for temporary protection.
 - c. Lumber for temporary support.
 - d. Pressure treatment of lumber specified in this Section.
 - e. Miscellaneous accessories.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before miscellaneous rough carpentry Work.

C. Related Sections:

1. Section 05 05 33, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ALSC PS 20, American Softwood Lumber Standard.
2. ASME B18.2.1 Square and Hex Bolts and Screws, Inch Series.
3. ASME B18.6.1 Wood Screws, Inch Series.
4. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
5. ASTM D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing

6. ASTM D5516, Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures.
7. ASTM D5664, Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
8. ASTM D6305, Practice for Calculating Bending Strength Design Adjustment Factors for Fire-Retardant-Treated Plywood Roof Sheathing.
9. ASTM D6841, Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber.
10. ASTM F1667, Specification for Driven Fasteners: Nails, Spikes, and Staples.
11. AWP A M4, Care of Preservative Treated Wood Products.
12. AWP A P5, Waterborne Preservatives.
13. AWP A P17, Fire Retardant Formulations.
14. AWP A T1, Use Category System: Processing and Treatment Standard.
15. AWP A U1, Use Category System: User Specification for Treated Wood.
16. APA E445S, Performance Standards and Policies for Structural-Use Panels (APA PRP-108).
17. NIST PS-1, Construction and Industrial Plywood.
18. National Lumber Grade Authority (NLGA), Standard Grading Rules for Canadian Lumber.
19. Northeastern Lumber Manufacturers Association (NELMA), Standard Grading Rules for Northeastern Lumber.
20. Southern Pine Inspection Bureau (SPIB), Standard Grading Rules for Southern Pine Lumber.
21. West Coast Lumber Inspection Bureau (WCLIB), Standard Grading Rules.
22. Western Wood Products Association (WWPA), Western Lumber Grading Rules.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of authorities having jurisdiction and the building code referred to in Section 01 42 00, References for size, spacing and attachment of wood members, unless more stringent requirements are shown or specified in the Contract Documents.
- B. Certifications:
 1. Pressure Treatment: For each type of pressure treatment specified, submit certification by wood treating plant stating chemicals and process used, and certifying conformance with applicable standards referenced in the Contract Documents.
 - a. For water borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to the Site.
 2. Certificates of Grade: Where appearance of wood is important and grade marks will deface the Work, in lieu of grade markings on wood, submit certificates attesting that materials comply with grade requirements specified.

1.4 SUBMITTALS

- A. Action Submittals; Submit the following:
 - 1. Shop Drawings:
 - a. List of species and grade of lumber proposed for each use.
 - b. Fastener schedule with location, size, material and type of each fastener to be used in the Work.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Lumber treater's certification of compliance, in accordance with Paragraph 1.3.B.1 of this Section.
 - b. Certificates of grade in accordance with Paragraph 1.3.B.2 of this Section.
 - 2. Tests and Evaluation Reports:
 - a. For fire retardant treated structural panels, test data and design adjustment values in accordance with ASTM D5516 and ASTM D6305.
 - b. For fire retardant treated lumber, test data and design adjustment in accordance with ASTM D5664 and ASTM D6841.
 - 3. Manufacturer's Instructions:
 - a. Chemical treatment manufacturer's instructions for proper use of each type of treated material.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete or masonry in ample time to prevent delaying the Work.
 - 2. Handle treated materials in accordance with AWWA M4.
 - 3. Comply with Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
 - 1. Keep materials dry during delivery and storage.
 - 2. Keep materials off ground using pallets, platforms, or other appropriate supports. Protect materials from corrosion and deterioration. Stack lumber, and provide air circulation within stacks.
 - 3. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Lumber, General:

1. Factory-mark each piece of lumber with type, grade, mill and grading agency. Surfaces that will be exposed to view shall not have grade marks or other types of identifying marks.
 2. Nominal sizes are shown or indicated, unless otherwise shown or indicated in the Contract Documents. Provide actual sizes as required by ALSC PS 20 for moisture content specified for each use.
 - a. Provide dressed lumber, surfaced four sides (S4S), unless otherwise shown or specified.
 - b. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing.
 3. Provide the following grade and species:
 - a. Construction Grade, for material up to and including four-inch wide.
 - b. No. 2 or better for material greater than four-inch wide up to and including 12-inch wide.
 - d. Eastern White Pine, NELMA.
 4. Lumber for Protection and Temporary Support: Size and grades to conform to Laws and Regulations, including OSHA.
- B. Plywood for Diaphragms and Roof Sheathing: Provide the following:
1. NIST PS-1 rated sheathing, exterior exposure, Grade C-C, with minimum thickness shown on the Drawings, and span rating not less than 24/0.
 - a. Mark each sheet to identify plywood by species group or span rating, exposure durability classification, grade, and compliance with NIST PS-1) Surfaces that will be exposed to view shall not bear grade marks or other identifying marks.
 - b. Provide Grade CDX for roof sheathing.
- C. Fasteners and Anchorages:
1. Fasteners exposed to the weather as well as fasteners embedded in, or in contact with, preservative treated wood shall be hot-dip galvanized.
 2. Fasteners for fire retardant-treated lumber exposed to the weather shall be copper alloy.
 3. Common wire nails shall conform to ASTM F1667.
 4. Wood screws shall conform to ASME B18.6.1.
 5. Lag screws and lag bolts shall conform to ASME B18.2.1.
 6. Anchorage devices shall conform to Section 05 05 33, Anchor Systems.
 7. Use joist hangers, framing anchors and clips where shown or specified.
 - a. Joist hangers shall be steel, zinc coated, sized to fit the supporting member, of sufficient strength to develop full strength of the supported member in accordance with applicable building code, and furnished complete with special nails required by joist hanger manufacturer.
 - b. Framing anchors shall be hot-dip galvanized steel conforming to ASTM A653/A653M, Z275 G90. Steel shall not be lighter than 18-gage. Use special nails furnished by manufacturer for nailing.
 - c. Clips shall consist of hot-dip galvanized conforming to ASTM A653/A653M, Z275 G90 steel angles, minimum 3/16-inch thick.

D. Wood Trim:

1. Western red cedar, custom grade.
2. Provide solid wood boards and battens complying with ALSC PS 20 and with applicable grading rules of authorized lumber inspection bureau or association under which each species is produced, S4S, with square edges.
3. Provide dressed, seasoned boards and battens with 15 percent maximum moisture content complying with dry size requirements of ALSC PS 20. Mark boards "MC-15" (moisture content 15 percent) or "KD" (kiln dried).

E. Panel edge clips: Extruded galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.

2.2 WOOD TREATMENT

A. Preservative Treatment: Where lumber is specified in this Section as treated, comply with AWP A P5, "Alkaline Copper Quat Mixture". Mark each treated item to comply with AWP A quality mark requirements.

1. Pressure-treat above ground items with water-borne preservatives in accordance with AWP A U1 and AWP A T1. After treatment, kiln-dry to maximum moisture content of 19 percent. Treat materials indicated on the Drawings and the following:
 - a. Wood nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - b. Wood, plates, blocking, furring, stripping, and similar concealed members and wood in contact with masonry, concrete, or steel.
 - c. Soffit and rain drainage framing.
2. Complete the fabrication of treated items prior to treatment, wherever possible. If wood is cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of wood after drying and discard damaged or defective pieces.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine substrates and supporting structure and conditions under which miscellaneous rough carpentry Work will be installed and notify ENGINEER in writing of conditions detrimental to proper completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Coordination: Fit miscellaneous rough carpentry Work to other Work and work under other contracts, as applicable, and scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other construction.

B. General:

1. Discard units of material with defects that might impair quality of the Work, and units too small to fabricate the Work with minimum joints or optimum joint arrangement.
2. Set miscellaneous rough carpentry Work accurately to required levels and lines, with members plumb and true, accurately cut and fitted.
3. Securely attach miscellaneous rough carpentry Work to substrates by anchoring and fastening as shown and indicated in the Contract Documents. Countersink nail heads on exposed miscellaneous rough carpentry Work and fill holes. Make tight connections between members.
4. Install fasteners without splitting of wood, pre-drill as required and for masonry anchors fastened to wood stud wall framing.

C. Wood Grounds, Nailers, and Blocking:

1. Provide where shown or indicated, and where required for attachment of other construction. Form to shapes as shown or indicated and cut as required for true line and level of Work to be attached. Coordinate location with other work involved.
2. Attach substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown or indicated.
3. Provide permanent grounds of dressed, preservative-treated, key-bevelled lumber not less than 1.5-inch wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

D. Plywood, General:

1. Install in accordance with the Contract Documents and requirements of authorities having jurisdiction.
2. Allow for installed clearances between individual plywood panels as specified by plywood manufacturer. Provide 1/4-inch space at panel edge joints and 1/8-inch space at panel end joints, unless otherwise recommended by manufacturer.
3. Install plywood with long dimension across supports.
4. Install roof sheathing using 8d helical or annular nails spaced six inches at panel edges and 12 inches at intermediate framing.
5. Provide panel edge clips at unsupported edges of roof sheathing.

E. Plywood, Diaphragm:

1. Diaphragms shall be blocked or unblocked, as shown or indicated on the Drawings. Comply with nailing schedule on the Drawings.
2. Provide continuous lumber blocking at unsupported edges of blocked diaphragms. Do not use panel edge clips in blocked diaphragms.

F. Air and Water Infiltration Barrier:

1. Install air and water infiltration barrier over entire wall area of wood framed building, as shown or indicated in the Contract Documents.

2. Comply with manufacturer's written installation instruction and provide large head sheathing nails sufficiently long to penetrate and grip framing studs, sills, and plates.
 3. Fabric shall be snugly taunt before nailing with all fabric lapped 12-inches minimum, at splices.
 4. Tape all seams along sills.
- G. Vapor Barrier:
1. Install vapor barrier over entire interior room-side surfaces of exterior gypsum board perimeter walls, and over entire interior room-side surface plane of bottom of ceiling joists.
 2. Install in accordance with manufacturer's written recommendations and using all taped joints and all taped fastener location to maintain perm rating of entire installed system in accordance with the Contract Documents.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 07 11 13

BITUMINOUS DAMPPROOFING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install bituminous dampproofing.
2. Extent of bituminous dampproofing is not shown.
 - a. Provide bituminous dampproofing on the outside face of all new backup concrete block walls at exterior walls.
3. Types of products required include the following:
 - a. Cold-applied asphalt semi-fibrated, solvent-based, Asbestos-free dampproofing, for exterior structure and wall surfaces above- and below-grade.
 - b. Cold-applied asphalt semi-fibrated, water emulsion, Asbestos-free dampproofing, for exterior structure and wall surfaces above- and below-grade.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before bituminous dampproofing Work.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASTM D1187, Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
2. ASTM D1227, Specification for Emulsified Asphalt Used as Protective Coating for Roofing.
3. ASTM D4479, Specification for Asphalt Roof Coatings—Asbestos-Free.
4. ASTM D4586, Specification for Asphalt Roof Cement, Asbestos-Free.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:

1. Provide all bituminous dampproofing of each type required produced by one manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Schedule of all Project-specific surfaces where bituminous dampproofing will be applied.
 - 2. Product Data:
 - a. Manufacturer's specifications and technical data for each required dampproofing material. Indicate VOC content of materials proposed.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Submit bituminous dampproofing manufacturer's certification or other data substantiating that materials proposed for use comply with the Contract Documents, and are recommended by bituminous dampproofing manufacturer for the required applications.
 - 2. Supplier's Instructions:
 - a. Manufacturer's instructions for handling and storing.
 - b. Manufacturer's instructions for application methods and application procedures.
 - 3. Qualifications Statements:
 - a. Installer: Submit copy of manufacturer's acceptance of installer and installer's record of experience in work similar to that required under this Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage of Materials:
 - 1. Store emulsions at temperatures above 40 degrees F.
- B. Handling of Materials:
 - 1. Do not open containers or mix components until preparatory Work is completed.
 - 2. Do not use solvent-based bituminous dampproofing without adequate ventilation. Prevent build-up of explosive and hazardous fumes.

1.6 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Do not install bituminous dampproofing when ambient air temperature is 40 degrees F or less.
 - 2. Do not apply bituminous dampproofing materials to frozen substrates or to substrate in condition not complying with bituminous dampproofing material manufacturer's recommendations.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. For interior and concealed-in-wall uses, provide bituminous dampproofing material that is odor-free after drying for 24 hours.
- B. Cold-Applied, Cut-Back Asphalt Dampproofing:
 - 1. Asphalt Compound: Manufacturer's standard asphalt and cut-back solvent-based compound with mineral stabilizers, recommended for below-grade exterior and for above-grade interior applications, compounded to penetrate the substrate and build to a moisture-resistant, firm, elastic coating.
- C. Cold-Applied Asphalt Emulsion Dampproofing:
 - 1. Asphalt Emulsion: Manufacturer's standard asphalt and water emulsion, recommended by bituminous dampproofing material manufacturer for below-grade exterior and above-grade interior applications to either damp (green) or dry substrates, compounded to penetrate the substrate and build to a moisture-resistant, breathing-type of elastic coating.
 - 2. Semi-Fibrated, Semi-Mastic Emulsion Dampproofing Material:
 - a. Provide semi-fibrated, semi-mastic, emulsion type, brush-applied, dampproofing compound complying with ASTM D1227, Type II, Class I.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Hydrocide 700B Semimastic, by ChemRex, Inc., Sonneborn Building Products Division.
 - 2) 220 AF Fibered Emulsion Dampproofing, by Karnak Chemical Corporation.
 - 3) Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine the substrates and conditions under which bituminous dampproofing Work will be applied, and advise ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. General:
 - 1. Do not proceed with bituminous dampproofing Work until blocking, nailers, piping, conduits, and other projections through the substrate are installed, with substrate properly patched and sealed or flashed to receive the bituminous dampproofing.

B. Surface Preparation:

1. Remove from the substrate dirt, oil, loose materials, and other substances that interfere with penetration, bond, and performance of bituminous dampproofing materials.
2. Dampen with water surfaces that are dry and are to receive application of bituminous dampproofing. Keep such surfaces damp ahead of application.

3.3 INSTALLATION

A. Cold-Applied, Cut-Back Bituminous Dampproofing on Exterior and Interior Surfaces:

1. Prime the substrate when recommended by bituminous dampproofing manufacturer's instructions, using the type and quantity of primer recommended by bituminous dampproofing manufacturer.
2. Apply coating of cold-applied, semi-fibrated, semi-mastic bituminous dampproofing material by brushing or spraying at the rate of one gallon per 20 square feet, to provide uniform dry film thickness of not less than 1/16-inch.
3. Cant Strips, Fillers and Extension of Coatings:
 - a. On exterior surfaces, where lower edge of dampproofing terminates at a horizontal projection (including footings under walls), provide two-inch by two-inch bituminous grout cant strip.
 - b. Mix sand with required bituminous material to form a plastic grout; form and compact in place. Provide bituminous grout fillers where shown and where required to close openings in the substrate.
 - c. Extend coatings a distance of 12 inches onto adjoining walls, but do not extend onto surfaces to remain exposed-to-view.
4. Fill cracks, crevices, and grooves. Coating shall be continuous and free of breaks and pinholes. Spread dampproofing around joints, grooves, and slots, and into all chases, corners, reveals, and soffits.

B. Cold-Applied Bituminous Dampproofing Emulsions on Exterior and Interior Surfaces:

1. Apply coating of semi-fibrated, semi-mastic, bituminous emulsion dampproofing material by brushing or spraying at the rate of one gallon per 20 square feet to produce uniform dry film thickness of not less than 1/16-inch.
2. Cant Strips, Fillers, and Extension of Coatings:
 - a. On exterior surfaces, where lower edge of dampproofing terminates at a horizontal projection (including footings under walls), provide two-inch by two-inch bituminous grout cant strip.
 - b. Mix sand with required bituminous material to form a plastic grout; form and compact grout in place. Provide bituminous grout fillers where shown and wherever required to close openings in the substrate.
 - c. Extend coatings a distance of 12-inches onto adjoining walls, but do not extend onto surfaces to remain exposed-to-view.

3.4 PROTECTION OF EXECUTED WORK

- A. Protect other work from spillage of bituminous dampproofing materials, and prevent such materials from penetrating and clogging drains, conductors, and other utilities.
- B. Remedy damage to other construction that is soiled or otherwise damaged during installation of bituminous dampproofing.

+ + END OF SECTION + +

+ + NO TEXT ON THIS PAGE+ +

SECTION 07 21 05

BUILDING INSULATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install building insulation.
2. Extent of each type of building insulation is shown and indicated in the Contract Documents.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before building insulation Work.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASTM C177, Test Methods for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
2. ASTM C203, Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
3. ASTM C236, Test Methods for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
4. ASTM C272, Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
5. ASTM C303, Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
6. ASTM C518, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
7. ASTM C520, Test Methods for Density of Granular Loose Fill Insulation.
8. ASTM C531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars and Monolithic Surfacing.
9. ASTM C549, Specification for Perlite Loose Fill Insulation.
10. ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
11. ASTM C578, Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.

13. ASTM C665, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
14. ASTM C764, Specification for Mineral Fiber Loose-Fill Thermal Insulation.
15. ASTM D696, Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C with a Vitreous silica dilatometer.
16. ASTM D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
17. ASTM D2126, Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
18. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.
19. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
20. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
21. UL 1479, Fire Tests of Through-Penetration Firestops.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers:
 - a. Obtain building insulations, requiring hydrochlorofluorocarbon blowing agent from manufacturer(s) that manufacture product required using blowing agent acceptable for use until the year 2020 and complying in all respects with Copenhagen Amendments to the Montreal Protocol.
 - b. Manufacturer shall provide complete technical services including preparation and review of Shop Drawings and submittals, installation methods, and proposed detailing for the Work.
2. Installer: Engage single installer for each type of building insulation. Each installer shall be skilled, trained, and have record of successful experience in applying and installing each product, and possess successful record of performing work in accordance with recommendations and requirements of manufacturer or that can submit written evidence of being acceptable to manufacturer for providing the required Work. Installers shall employ only tradesmen with specific skill and successful experience in each type of Work required. Submit to ENGINEER name and qualifications of each installer with the following information for at least three successful, completed projects per installer:
 - a. Names and telephone numbers of owner and architect or engineer responsible for each project.
 - b. Approximate contract cost of the building insulation system installed.
 - c. Quantity (area) of building insulation installed.

B. Regulatory Requirements: Comply with code interpretations by authorities having jurisdiction at the Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Drawings showing extent of the building insulation Work and all details required for the Work, referencing system components provided as Samples.
 - b. Complete selection of fire stop manufacturer's recommended systems for each condition and kind of penetration encountered in the Work. Coordinate with equipment manufacturers for required number and kind of penetrations through fire-rated construction. Provide schedule of penetrations and fire stop system to be included for each condition and kind of penetration encountered.
2. Product Data:
 - a. Material specifications and general recommendations from building insulation manufacturer for each type of building insulation product. Include manufacturer's data substantiating that materials comply with Contract Documents.
 - b. Test Reports: Copies of reports of tests on materials being furnished or previously-manufactured, identical materials verifying compliance with physical properties and environmental features specified in the Contract Documents. When requested by ENGINEER, submit qualifications and summary of experience of testing agencies in performing tests similar to those required.

B. Informational Submittals: Submit the following:

1. Manufacturer's Instructions: Manufacturer's installation instructions. Indicate by copy of transmittal form that installer has received copy of manufacturer's installation instructions.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling of Materials:

1. Do not deliver insulation materials to the Site before the time of installation.
2. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.
3. Handle materials carefully to avoid damage and breakage or compressing of boards to less than their specified thickness, or other damage.
4. Handle materials in manner that prevents inclusion of foreign materials.
5. Conform to Section 01 65 00, Product Delivery Requirements.

B. Storage of Materials:

1. Store materials in dry, enclosed area, off ground and away from possible contact with water, ice, and snow.
2. Prevent damage to materials during storage, including minimizing the time materials are stored at the Site before being incorporated into the Work. Store

only sufficient quantity of building insulation materials at the Site required for continuous advancement of the Work without causing delay.

3. Conform to Section 01 66 00, Product Storage and Handling Requirements.

1.6 SITE CONDITIONS

A. Environmental Conditions:

1. Complete the installation and concealment of building insulation materials as rapidly as possible to avoid damage from adjacent construction operations and adverse weather conditions.
2. Install building insulations when weather and temperature conditions comply with building insulations manufacturers' written recommendations.
3. Install building insulations when damaging environmental condition are not forecasted for the time when exposed systems materials components would be exposed to potential damage from the elements.
4. Protect building insulation Work from precipitation, frost, and direct sunlight.
5. Do not apply pressure-sensitive tape when temperature is below 35 degrees F or above 110 degrees F.
6. Record decisions, conditions, and agreements to proceed with the Work when weather conditions may be unfavorable. State reasons for proceeding, along with names of persons involved, and changes or revisions (if any), if required, to allow the Work to proceed.

1.7 SCHEDULING

- A. Proceed with building insulation Work when preceding Work is ready to receive the Work of this Section.
- B. Proceed with building insulation and associated Work after curbs, blocking, substrate board, nailer strips, vents, drains and other projections through the substrates have been installed, and when substrate construction and framing of openings is complete.
- C. Proceed with and complete the Work when materials, equipment and tradesmen required for the installation of building insulation and backfilling operations are at the Site and ready to follow with the Work in manner that does not leave the Work vulnerable to damage or deterioration.
- D. Do not advance installation of building insulation beyond that necessary for proper sequencing of the Work. Do not advance the Work when there is no proper and secure protection from damaging weather and construction activities.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:

1. Thermal Conductivity: Thicknesses shown are for thermal conductivity, k-value at 75 degrees F, specified for each material.
2. Provide adjusted thicknesses based on thicknesses shown or specified for building insulations, as required to comply with required thermal resistances for material having different thermal conductivity.

2.2 MATERIALS

- A. Glass Fiber Insulations: Provide the following types:
1. General: Provide insulations formed from glass fibers and resinous binders fabricated into flexible blankets, semi-rigid and rigid sheets complying with ASTM C665, ASTM C553, and ASTM C612.
 2. Flame-resistant Vapor Barrier Faced Batt Insulation: Provide thermal batt insulation, faced on one side with foil-reinforced-kraft laminate vapor barrier complying with ASTM C665, Type III, Class A.
 - a. Physical Properties:
 - 1) Thermal Conductivity (k), ASTM C518: 0.33 Btu/inch/hour/square foot/degree F maximum.
 - 2) Density, ASTM C303: 1.5 pounds per cubic foot (pcf).
 - 3) Water Vapor Transmission, ASTM E96: 0.10 perm/inch.
 - 4) Flame Spread, ASTM E84: 25.
 - 5) Smoke Developed, ASTM E84: 50.
 - 6) Fuel Contributed, ASTM E84: 50.
 - b. Thickness: 9.5 inches minimum.
 - c. Width: as required for conditions encountered.
 - d. Products and Manufacturers: Provide one of the following:
 - 1) FS-25 FRK Faced Thermal Batt Insulation by Owens-Corning Fiberglass Corporation.
 - 2) FSK-25 Thermal Batt Insulation by Johns Manville.
 - 3) Or equal.
- B. Mineral Fiber Insulation: Provide the following types:
1. General: Provide insulations formed from inorganic mineral fiber extrusions spun at 2,500 degrees F complying with ASTM C665 and ASTM C764.
 2. Loose Mineral Fiber Insulation: Provide non-asbestos rock, slag, or glass processed into fiber and formed into loose resilient wool mass or granular nodules complying with ASTM C764, Type 1 (for blowing) Type 2 (for pouring).
 - a. Physical Properties:
 - 1) Thermal Conductivity (k), ASTM C764: 0.46 Btu/inch/hour/square foot/degree F.
 - 2) Ignition Loss: Less than one percent (99 percent pure mineral fiber).
 - 3) Density, ASTM C 64: 1.5 pounds per cubic foot (pcf).
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Industrial Mineral Wool Fiber by Rock Wool Industries, Inc.
 - 2) FBX Insulating Wool by Fibrex, Inc.
 - 3) Or equal.

3. Sound Attenuation Fire Blanket Insulation: Provide insulation containing non-asbestos, non-combustible compounds of spun mineral fiber felt formed into flexible, resilient blankets complying with ASTM C665, Type I.
 - a. Physical Properties:
 - 1) Thermal Conductivity (k), ASTM C518: 0.27 Btu/inch/hour/square foot/degree F.
 - 2) Density, Manufacturer's Certified Test: 2.5 pounds per cubic foot (pcf).
 - b. Thickness: Three inches.
 - c. Width: 16 inches.
 - d. Products and Manufacturers: Provide one of the following:
 - 1) Thermafiber SAFB Batts by USG Interiors, Inc.
 - 2) Sound Control Fire Blankets by Fibrex, Inc.
 - 3) Or equal.
 4. Safing Insulation: Provide unfaced semi-rigid non-asbestos, non-combustible blankets composed of compounds of spun mineral fiber felt, complying with ASTM C665, Type I.
 - a. Physical Properties:
 - 1) Thermal Conductivity (k), ASTM C518: 0.25 Btu/inch/hour/square foot/degree F.
 - 2) Density, Manufacturer's Certified Test: Four pounds per cubic foot (pcf).
 - 3) Flame Spread, ASTM E84: 15 maximum.
 - 4) Smoke Developed, ASTM E84: Five maximum.
 - 5) Fire Resistance Rating, ASTM E119: Three hours.
 - b. Thickness: Four inches.
 - c. Width: 2.0 feet.
 - d. Products and Manufacturers: Provide one of the following:
 - 1) Thermafiber Safing Insulation by USG Interiors, Inc.
 - 2) FBX Safing Insulation by Fibrex, Inc.
 - 3) Or equal.
- C. Fire-Stop Sealants and Other Fire-Stop System Components: Provide the following:
1. Complete selection of fire-stop manufacturer's recommended silicone rubber fire-stop systems. Provide complete systems complying with UL 1479 with two- or three-hour fire rating. Provide equal fire protection as provided by fire-rating of construction penetrated.
 2. Provide multiple component systems coordinated to meet actual conditions encountered in the Work and as recommended by fire-stop manufacturer. In addition to providing fire resistance, fire-stop systems shall also be gas and watertight.
 3. Products and Manufacturers: Provide one of the following:
 - a. 3M Fire Stop Systems by 3M, Inc.
 - b. Or equal.

D. Miscellaneous Materials and Accessories: Provide the following:

1. Adhesive for Bonding Insulation: Type recommended by insulation manufacturer, and complying with fire resistance requirements.
2. Mechanical Anchors: Type and size shown or, if not shown, as recommended by insulation manufacturer for type of application shown and condition of substrate.
3. Safing Impaling Clips: Provide galvanized steel impaling clips complying with requirements of code authorities having jurisdiction at the Site and as recommended by insulation manufacturer for full system responsibility.
4. Protection Board: Fiberboard sheathing or heavy duty asphaltic panels as recommended by insulation manufacturer.
5. Adhesive Tapes: Complete selection of insulation manufacturer's recommended taping materials.
6. Bitumen: Asphalt, ASTM D 449.

PART 3 – EXECUTION

3.1 INSPECTION

- A. CONTRACTOR and installer shall examine substrate and conditions under which building insulation Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surfaces to receive building insulation shall be clean of all debris, dirt, and other contamination before installation begins.

3.3 INSTALLATION

- A. General:
 1. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to Site conditions, before proceeding with the Work obtain from manufacturer and submit to ENGINEER specific installation recommendations from manufacturer.
 2. Extend insulations full thickness over entire surface to be insulated. Cut and fit tightly around obstructions. Fill voids with insulation.
 3. Apply number of layers of insulation specified, each of required thickness, or required thickness to provide thermal value shown or indicated in the Contract Documents, to make up the total thickness.
- B. Unit-type Building Insulation:
 1. Apply insulation units of type shown or indicated to substrate by method indicated. If not otherwise indicated and except for units resting on horizontal

surfaces, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

2. Seal joints between closed-cell (non-breathing) insulation units by applying mastic or sealant of type recommended by the manufacturer to edge of each unit to form tight seal as units are shoved into place. Fill voids in completed installation with mastic or sealant.
 3. Exercise extreme care to avoid damaging and soiling of faces on insulation units that will remain exposed-to-view. Align joints accurately, with adjoining surfaces set flush.
 4. Set vapor barrier faced units with vapor barrier to warm side of construction, (usually toward inside), except as otherwise shown or indicated. Do not obstruct ventilation spaces, except for fire-stopping.
 5. Tape joints and ruptures in vapor barriers using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction so as to ensure vapor-tight installation of the units.
- C. Safing Insulations and Fire-Stop Systems:
1. Install safing insulation and fire-stop systems to present continuous fire-rated fire barrier in areas shown and at perimeter of all fire-rated partitions and poke-through floor and wall penetrations, to maintain continuity of fire-rated construction whether or not shown.
 2. Install fire stop sealants and other fire stop system components in thicknesses recommended by manufacturer at all locations where poke-through penetrations occur, at all locations where other penetrations such as ducts, pipe, cables, cable trays, and conduit occur and at perimeter of all fire-rated walls.
 3. Include all components of manufacturer's fire/smoke-stop systems for complete system responsibility installed in accordance with manufacturer's written recommendations and specifications.
- D. Batt-type Insulation:
1. Install batt insulation above ceilings and between studs and rafters as shown. Extend insulation full width, length, and height in areas shown.
 2. Fit tightly around obstructions to form uniform, insulated barrier.
- E. Correcting Defective Work:
1. System components that are dislodged, damaged, expanded, broken, penetrated, or crushed by subsequent installation operations or damaged by detrimental weather shall be immediately replaced with undamaged material in compliance with the Contract Documents and properly protected as specified.
 2. Only original installer shall repair or replace deteriorated or defective Work.

3.4 PROTECTION

- A. Protection from Elements:
1. Protect all components of the Work from detrimental weather conditions. Do not allow building insulation materials to become wet or soiled, or covered

with ice or snow. Provide continuous protection of materials against damage, wetting and moisture absorption and storing materials as specified

2. Work that cannot, for reasons acceptable to ENGINEER, be covered with complete construction system before onset of weather detrimental to the Work, shall be completely covered and protected in manner that deflects precipitation from building insulations without damaging adjacent Work.
- B. Protection During Construction:
1. Protect all components of the Work from construction operations including, but not limited to, backfilling, framing, and sheathing, aluminum siding, and concrete unit masonry Work, until work is completed and acceptable to ENGINEER.
 2. Protect building insulations from damage and abuse by other contractors and installers until readiness for final payment.
 3. Do not allow building insulations to come into contact with welding operations or other fire or ignition sources.
 4. Do not allow construction traffic not associated with installation of building insulation in the area of building insulation Work. Protect the area from access by other installers and contractors until the building insulation Work has been incorporated into finished construction systems.
- C. Building insulation that becomes wet, damaged, or deteriorated shall be promptly removed from the Site and replaced with materials conforming to this Section.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE++

SECTION 07 92 00

JOINT SEALANTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install joint sealants.
2. Extent of each type of calking and sealant is shown or indicated and includes the following:
 - a. Interior and exterior joints in equipment and construction systems not filled by another material, and that are not required to be open for operation in all new and existing joints, openings, walls, etc.
 - b. Exposed-to-view joints of all fire-rated sealants.
 - c. Joints specified to be recalked.

B. Coordination:

1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before joint sealants.
2. Coordinate final selection of joint sealants so that materials are compatible with all calking and sealant substrates specified.

C. Related Sections:

1. Section 04 00 05, Masonry.
2. Section 07 21 05, Building Insulation.
3. Section 08 81 00, Glass Glazing.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASTM C510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
2. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
3. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
4. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
5. ASTM C920, Specification for Elastomeric Joint Sealants.
6. ASTM C1021, Practice for Laboratories Engaged in Testing Building Sealants.
7. ASTM C1087, Test method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
8. ASTM C1193, Guide for Use of Joint Sealants.

9. ASTM C1247, Practice for Durability of Sealants Exposed to Continuous Immersion in Liquids.
10. BAAQMD Regulation 8, Rule 51.
11. FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
12. FS TT-S-00230 Sealing Compound: Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
13. NSF/ANSI Standard 61, Drinking Water System Components - Health Effects.
14. SCAQMD Rule 1168.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Installer:
 - a. Engage a single installer, approved by product manufacturer, regularly engaged in calking and sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of Work required.
2. Testing Laboratory:
 - a. Furnish services of independent testing laboratory qualified according to ASTM C1021, for conducting testing required.

B. Component Supply and Compatibility:

1. Obtain materials only from manufacturers who will, if required:
 - a. Furnish at the Site services of a qualified technical representative to advise installer of proper procedures and precautions for using materials.
 - b. Test joint sealants for compatibility with substrates for conformance with FS-TT-S-00227, and recommend remedial procedures as required.
2. Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Shop Drawings and other approved submittals.

C. Product Testing: Provide test results of laboratory pre-construction compatibility and adhesion testing, as specified in Article 3.1 of this Section, by qualified testing laboratory, based on testing of current sealant formulations within a 36-month period preceding the Notice to Proceed for the Work.

1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920 and, where applicable, to other standard test methods.
2. Test other joint sealants for compliance using specified post-construction field adhesion test.

D. Mock-ups:

1. Prior to installing joint sealant Work but after ENGINEER's approval of Samples, provide Sample of each type of calking and sealant in areas selected by ENGINEER to show representative installation of calkings and sealants.

Obtain ENGINEER's approval of visual qualities of mock-ups before starting calking and sealant Work. Retain and protect mock-ups during construction as a standard for judging completed calking and sealant Work. Do not alter or destroy mock-ups until so allowed by ENGINEER.

2. Perform the following testing on calking and sealant mock-up, as specified in this Section: Post-construction field adhesion testing and water leak test.
3. Work that does not comply with test requirements on Sample areas will be considered defective.

E. Pre-installation Conference:

1. Prior to installing joint sealants and associated Work, schedule and meet at the Site with calking and sealant installer, calking and sealant manufacturer's technical representative, other trades involved in coordinating with calking and sealant Work, ENGINEER, and OWNER. Record discussions of pre-installation conference and decisions, agreements, and disagreements, and furnish copy of record to each party attending conference. Review foreseeable methods and procedures related to calking and sealant Work, including reviewing:
 - a. Required submittals, both completed and yet to be completed.
 - b. Status of test reports.
 - c. Mock-up construction results.
 - d. Status of substrate and similar considerations.
 - e. Each major calking and sealant application required.
 - f. Availability of products, tradesmen, equipment, and facilities required for avoiding delays.
2. Reconvene conference at earliest opportunity if additional information must be developed to conclude subjects under consideration.
3. Record revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Schedule of joint sealants installation, indication each specific surface where calking or sealants are to be provided and the material proposed for each application.
2. Product Data:
 - a. Copies of manufacturer's data sheets including color charts, specifications, recommendations, and installation instructions for each type of sealant, calking compound, and associated miscellaneous material required. Include manufacturer's published data, indicating that each product complies with the Contract Documents and is intended for the applications shown or indicated.
 - b. Product test reports.
3. Samples:

- a. Each type of actual cured material of each calking and sealant specified, in each of manufacturer's standard colors.
- b. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is responsibility of CONTRACTOR.

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Certify that materials are suitable for intended use and materials meet or exceed requirements of the Contract Documents.
 - b. Certification from manufacturer that products furnished are appropriate for surfaces and conditions to which they will be applied.
 - c. Certify that applicator is approved by manufacturer.
- 2. Field Quality Control Submittals:
 - a. Results of tests on job mock-ups.
 - b. Pre-construction and post-construction field test reports.
 - c. Compatibility and adhesion test reports.
 - d. Contractor's Field Test Report Logs:
 - 1) Indicate time present at the Site.
 - 2) Include observations and results of field tests, and document compliance with manufacturer's installation instructions and supplemental instructions provided to installers.
- 3. Pre-installation conference record.
- 4. Qualifications: Submit qualifications for:
 - a. Installer.
 - b. Testing laboratory (if not already submitted under Section 01 45 23, Testing Laboratory Services Furnished by Owner, or Section 01 45 13, Testing Laboratory Services Furnished by Contractor).

C. Closeout Submittals: Submit the following:

- 1. Operation and Maintenance Data:
 - a. Recommended inspection intervals.
 - b. Instructions for repairing and replacing failed sealant joints.
- 2. Warranty: Submit written warranties as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 65 00, Product Delivery Requirements, and Section 01 66 00, Product Storage and Handling Requirements, and the following:

- 1. Delivery of Products:
 - a. Deliver products in calking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
 - b. Include the following information on label:
 - 1) Name of material and Supplier.
 - 2) Formula or Specification Section number, lot number, color and date of manufacture.
 - 3) Mixing instructions, shelf life, and curing time, when applicable.

2. Storage of Products:
 - a. Do not store or expose materials to temperature above 90 degrees F or store in direct sunlight.
 - b. Do not use materials that are outdated as indicated by shelf life.
 - c. Store sealant tape in manner that will not deform tape.
 - d. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 75 degrees F.
 - e. When high temperatures prevail, store mixed sealants in a cool place.
3. Handling:
 - a. Do not open containers or mix components until necessary preparatory Work and priming are complete.

1.6 JOB CONDITIONS

- A. Environmental Conditions:
 1. Do not install joint sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
 2. Proceed with the Work when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
 3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
 4. When high temperatures prevail, avoid mixing sealants in direct sunlight.
 5. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
 6. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.
 7. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas of calking, sealants, and painting Work, and areas where OWNER's personnel or construction personnel may work. Properly locate and vent such heat sources to outdoors so that joint sealants and other Work are unaffected by exhaust.

1.7 WARRANTY

- A. Provide written warranty, signed by manufacturer and CONTRACTOR, agreeing to repair or replace sealants that fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in approved Shop Drawings and other submittals, as an inherent quality of material for exposure indicated.
 1. Provide manufacturer warranty for period of one year from date of Substantial Completion of joint sealants Work.

2. Provide installer warranty for period of two years from date of Substantial Completion of joint sealants Work.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. VOC Performance Criteria:
 1. VOC content of sealants used shall comply with current VOC content limits of SCAQMD Rule 1168. Sealants used as fillers shall comply with or exceed requirements of BAAQMD Regulation 8, Rule 51.
 - a. Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L.
- C. Provide colors selected by ENGINEER from calking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide same generic products and colors as available from manufacturers specified.

2.2 MATERIALS

- A. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Wastewater:
 1. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or equal.
 - b. Polyurethane based, two-component elastomeric sealant complying with:
 - 1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
 - 2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 18 lbs.
 - 3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
 - 4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
 - 7) VOC Content: 220 grams per liter, maximum.

B. Exterior and Interior Vertical Joints; Non-submerged:

1. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or equal.
 - b. Polyurethane based, two-component elastomeric sealant complying with:
 - 1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
 - 2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 10 pounds.
 - 3) Hardness (Standard Conditions), ASTM C661: 25 to 35 (Shore A).
 - 4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
 - 7) VOC Content: 100 g/L, maximum.

C. Exterior and Interior Horizontal Joints; Non-submerged:

1. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c SL by Sika Corporation.
 - 2) THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or equal.
 - b. Polyurethane based, two-component elastomeric, self-leveling sealant complying with the following:
 - 1) FS TT-S-00227E, Type I (self-leveling) Class A. and ASTM C920, Type M, Grade P, Class 25
 - 2) Water Immersion Bond, FS TT-S-00227E: Elongation of 50 percent with no adhesive failure.
 - 3) Hardness (Standard Conditions), ASTM C661: 35 to 45.
 - 4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) VOC Content: 165 g/L, maximum.

D. Miscellaneous Materials:

1. Joint Cleaner: As recommended by calking and sealant manufacturer.
2. Joint Primer and Sealer: As recommended for compatibility with calking and sealant by calking and sealant manufacturer.

3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended for compatibility with calking and sealant by calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape where applicable.
4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by calking and sealant manufacturer. Provide size and shape of rod that will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide highly-compressible backer to minimize possibility of sealant extrusion when joint is compressed.
5. Low-temperature Catalyst: As recommended by calking and sealant manufacturer.

E. Products for Other Applications:

1. Glazing Sealants: Refer to Section 08 81 00, Glass Glazing.
2. Fire-Rated Sealants: Refer to Section 07 21 05, Building Insulation.
3. Compressible Filler: Refer to Section 04 00 05, Masonry.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which calking and sealant Work will be performed, and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work and performance of sealants. Do not proceed with calking and sealant Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Protection: Do not allow joint sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or calking and sealant materials.
- B. Joint Surface Preparation:
1. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
 2. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.

3. Roughen joint surfaces on vitreous coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
 4. Concrete Joint Preparation: Refer to Section 03 15 00, Concrete Accessories
- C. Mixing:
1. Comply with sealant manufacturer's written instructions for mixing multi-component sealants.
 2. Thoroughly mix components before use.
 3. Add entire contents of activator can to base container. Do not mix partial units.
 4. Mix contents for minimum of five minutes or as recommended by sealant manufacturer, until color and consistency are uniform.

3.3 INSTALLATION

- A. Install joint sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure calking and sealant joints will not be soiled. Replace calking and sealant joints soiled after installation.
- B. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents, and except where manufacturer's technical representative directs otherwise, only as acceptable to ENGINEER.
- C. Prime or seal joint surfaces as shown on approved Shop Drawings and approved other submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.
- D. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.
- E. Confirm that compressible filler is installed before installing sealants. Refer to Section 04 05 05, Unit Masonry Construction, for locations.
- F. Do not install sealants without backer rods and bond breaker tape.
- G. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.
- H. Employ only proven installation techniques that will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

- I. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
 - 1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
 - 2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.
- J. Remove excess and spillage of compounds promptly as the Work progresses.
- K. Cure caulking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.

3.4 EXISTING JOINTS

- A. Mechanically remove existing sealant and backer rod.
- B. Clean joint surfaces of residual sealant and other contaminants capable of affecting sealant bond to joint surface.
- C. Conduct laboratory pre-construction compatibility and adhesion testing on joint surfaces in accordance with Paragraph 3.1.B of this Section.
- D. Allow joint surfaces to dry before installing new sealants.

3.5 FIELD QUALITY CONTROL

- A. Post-construction Field Adhesion Testing: Before installing elastomeric sealants, field-test joint sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform ten tests for the first 1,000 feet of joint length for each type of elastomeric sealant and joint substrate.
 - b. Perform one test for each 1,000 feet of joint length thereafter, and minimum of one test per each floor per elevation.
 - c. Test Method: Test joint sealants according to Method A, Field-applied Sealant Joint Hand Pull Tab, and Method D, Water Immersion in Appendix X1 of ASTM C1193. For joints with dissimilar substrates, verify adhesion to each substrate separately by extending cut along one side and verifying adhesion to opposite side. Repeat procedure for opposite side.
 - d. Inspect joints for complete fill, absence of voids, and joint configuration complying with specified requirements. Record results in a log of field adhesion tests.
 - e. Inspect tested joints and report on whether:

- 1) Sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 - 2) Sealants filled the joint cavities and are free of voids.
 - 3) Sealant dimensions and configurations comply with specified requirements.
- f. Record test results in a log of field adhesion tests. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - g. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
 - h. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other requirements will be satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
 - i. Do not proceed with installation of elastomeric sealants over joint surfaces that have been painted, lacquered, waterproofed, or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.
- B. Water Leak Testing: Field test for water leaks as follows:
1. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, two feet from joint and connected to water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
 2. Test approximately five percent of total joint system, in locations that are typical of every joint condition, and that can be inspected easily for leakage on opposite face. Conduct test in presence of ENGINEER, who will determine actual percentage of joints to be tested and actual period of exposure to water from hose, based on extent of observed leakage or lack of observed leakage.
 3. Where nature of observed leaks indicates potential of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion.

3.6 ADJUSTING AND CLEANING

- A. Where leaks and lack of adhesion are evident, replace sealant.

- B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish Work in neat, clean condition.
- C. Protect sealants during construction so that they will be without deterioration, soiling, or damage at time of readiness for final payment of the Contract.

3.7 PROTECTION

- A. During and after curing period, protect joint sealants from contact with contaminating substances and from damage resulting from construction operations or other causes, so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original Work.

3.8 WASTE MANAGEMENT

- A. Refer to Section 01 74 05, Cleaning, for sealant and surface preparation debris disposal requirements.

+ + END OF SECTION + +

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install hollow metal doors and frames.
2. Extent of hollow metal doors and frames is shown.
3. Types of products required include the following:
 - a. Seamless, galvanized steel, paper honeycomb core, internally reinforced, flush doors.
 - b. Seamless, galvanized steel, paper honeycomb core, internally reinforced, fire-rated, flush doors.
 - c. Transoms and panels.
 - d. Removable panels.
 - e. Removable transoms.
 - f. Miscellaneous supports; special, supplemental and standard finish hardware reinforcements and preparation items; fasteners and accessories; all for high frequency, high-endurance use.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the hollow metal doors and frames Work.

C. Related Sections:

1. Section 04 05 05, Unit Masonry Construction.
2. Section 07 92 00, Joint Sealants.
3. Section 08 71 00, Door Hardware.
4. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American National Standards Institute, (ANSI).
 - a. ANSI in association with Steel Door Institute, ANSI/SDI 100, Steel Doors and Frames.
 - b. ANSI in association with Door and Hardware Institute, ANSI/A115.1-A115.17/DHI, Specifications for Steel Door and Frame Preparation for Hardware.

- c. ANSI A224.1, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- d. ANSI A250.3, Test Procedure and Acceptance Criteria for Factory-Applied Finish Painted Steel Surfaces for Steel Doors and Frames.
- e. ANSI A250.4, Test Procedures and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings.
- f. ANSI A250.5, Accelerated Physical Endurance Test Procedure for Steel Doors, Frames, and Frame Anchors.
- g. ANSI/NFPA 252, Fire Tests of Door Assemblies.
- 2. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 153/A 153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. ASTM A 366, Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
 - c. ASTM A 653/A 653M, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by The Hot-Dip Process.
 - d. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
 - e. ASTM E 1408, Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems.
- 3. Door and Hardware Institute, (DHI).
 - a. DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
- 4. National Fire Protection Association, (NFPA).
 - a. NFPA 80, Fire Doors and Fire Windows.
- 5. Steel Door Institute, (SDI/Door).
 - a. SDI/Door 105, Erection Instructions for Steel Frames.
 - b. SDI/Door 106, Standard Door Type Nomenclature.
 - c. SDI/Door 112, Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames.
 - d. SDI/Door 117, Manufacturing Tolerances Standard Steel Doors and Frames.
 - e. SDI/Door 122, Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
 - f. SDI/Door 128, Guidelines for Acoustical Performance of Standard Steel Doors and Frames.
- 6. The Society for Protective Coatings, (SSPC).
 - a. SSPC Paint 2, Cold Phosphate Surface Treatment.
 - b. SSPC Paint 27, Basic Zinc Chromate-Vinyl Butyral Wash Primer.
- 7. Underwriters' Laboratories Inc., (UL).
 - a. UL 10B, Fire Tests of Door Assemblies.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

- 1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at

- least five installations in satisfactory operation for at least five years.
 2. Provide hollow metal doors, frames, and accessories manufactured by a single firm specializing in the production of this type of Work and complying with specified standards of ANSI, NFPA, SDI and UL.
 3. Provide hollow metal doors and frames from a manufacturer who is a member of SDI.
- B. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single hollow metal doors and frames manufacturer.
 2. The hollow metal doors and frames equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the hollow metal doors and frames manufacturer.
- C. Regulatory Requirements:
1. Fire-Resistance-Rated Assemblies: Wherever a fire-resistance classification is shown or scheduled for hollow metal doors and frames (3-hour, 1-1/2-hour, and similar designations), provide fire-resistance-rated hollow metal doors and frames tested as a fire door assembly, complete with type of fire door hardware to be used.
 2. Identify each fire-resistance-rated door and frame with recognized testing laboratory labels, indicating applicable fire-resistance-rating of both door and frame. Provide fire-resistance-rated doors and frames with metal labels permanently fastened to door and frame. Labels shall display all UL required information.
 3. Temperature Rise Rating: Wherever a temperature rise rating is required by the building code, provide doors for fire-resistance-ratings shown and in accordance with UL 10B.
 - a. For a UL 3-hour (A) classification, provide doors with a temperature rise rating of not more than 250°F maximum to 30 minutes of exposure.
 - b. For a UL 1-1/2-hour (B) classification, provide doors with a temperature rise rating of not more than 450°F or 650°F maximum to 30 minutes of exposure.
 4. Door and frame assemblies shall comply with NFPA 80, and as specified. Modify specified hollow metal door and frame system components to comply with requirements of governing jurisdictions for fire-resistance-rated construction.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:

- a. Fabrication and installation drawings of hollow metal doors and frames. Include details of each frame type, elevations of each door type, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints, connections and every composite member. Show all door and frame reinforcements, including welds, plate lengths, locations and gauges, identified for each component of finish hardware specified in Section 08 71 00, Door Hardware.
 - b. Provide a schedule of doors and frames using same reference numbers for details and openings as those shown.
- 2. Samples:
 - a. Pressed metal corner section of frame, 12-inches by 12-inches minimum, showing all special, supplemental and standard reinforcements, attachments, supports and anchors specified. Provide corner sample for each type of frame specified.
 - b. Stick system components showing corner detail and glazing stops of all types specified, 12-inches by 12-inches, minimum.
 - c. Cut-away section of all door types specified, showing internal construction, edge details and reinforcements for butts, closers and similar items of finished hardware, 2 foot-0 inches by 2 foot-0 inches minimum. Include louver sections, vision panel and glazing stops.
 - d. ENGINEER reserves the right to require samples showing fabrication techniques and workmanships of all component parts, and the detailing and fabrication of accessories and auxiliary items for all door and frame Work, before fabrication of the Work proceeds.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certification of Labeled Construction for fire-resistance-rated doors and frames.
 - b. Oversize Fire-resistance-rated Doors and Frames: Submit for approval UL certification for oversized fire-resistance-rated doors and frames verifying that each assembly has been constructed with materials and methods equivalent to requirements for labeled construction.
 - 2. Test and Evaluation Reports:
 - a. Test reports indicating compliance with ANSI A250.4 and ANSI A250.5.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
 - 2. Deliver hollow metal doors and frames cartoned or crated to provide protection during transit and job storage.

B. Storage and Protection:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store doors and frames at the Site under cover.
3. Place units up off floors in a manner that will prevent rust and damage.
4. Avoid the use of non-vented plastic or canvas shelters, which could create a humidity chamber. If cardboard wrapper on the door becomes wet, remove the carton immediately.
5. Provide a 1/4-inch space between stacked doors to promote air circulation.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:

1. Door Classification: Provide hollow metal doors of Grades and Models in accordance with ANSI/SDI 100, and ANSI A250.5 as follows:
 - a. Grade III, Extra Heavy-Duty, 1-3/4-inches thick (Level A); Model 2A, seamless design.

B. Details of Construction:

1. Provide doors of two outer stretcher-leveled sheets, 14-gauge minimum. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or edges, except around glazed or louvered panel inserts. No fillers shall be used. Provide weep hole openings in the bottom of exterior doors to permit the escape of entrapped moisture.
2. Reinforce inside of doors with honeycomb core completely filling the inside of the door and laminated to the inside of both face panels with an adhesive. The honeycomb material shall have a crushing strength not less than 6,000 pounds per square foot and the lamination shall withstand not less than 1,100 pounds per square foot in shear.

C. Frame Construction:

1. Form frames of cold-rolled sheet material, 14-gauge minimum. Provide seamless frames for all Work, unless specifically specified and shown as permitting exposed fasteners.

2. Provide hollow metal frames for doors, transoms, and other openings of size and profile as shown or specified.

2.2 MANUFACTURERS

- A. Products and Manufacturers: Provide one of the following:
 1. Series CH with DURA-WELD seams with Series F 14 Frames by Pioneer Industries, Incorporated.
 2. Or equal.

2.3 MATERIALS

- A. Door Faces and Frames: Zinc-coated, cold-rolled carbon steel sheets of commercial quality, complying with ASTM A 366, and ASTM A 653/A 653M, G 60 zinc coating, mill-phosphatized.
- B. Honeycomb Core: Phenolic resin-impregnated, nominal 1-inch hexagonal cell size, one piece, Kraft fiber core board, with 42 psi minimum crushing strength.
- C. Supports and Anchors: Formed sheet metal, hot-dip galvanized after fabrication complying with ASTM A 153/A 153M, Class B, and in compliance with requirements of ANSI A250.5. Provide supports and anchors as follows:
 1. Jamb Anchors: 16-gauge minimum, and of the following types:
 - a. Masonry Construction: Adjustable, corrugated or perforated, T-shaped to suit frame size with leg not less than 2-inches wide by 10-inches long.
 - b. In-Place Concrete or Masonry Construction: 3/8-inch concealed bolts and expansion shields or inserts.
 2. Floor and Head Anchors: 14-gauge minimum, and of the following types:
 - a. Monolithic Concrete Slabs: Clip-type, with two holes to receive fasteners, welded to bottom of jambs and mullions.
 - b. Separate Topping Concrete Slabs: Adjustable-type with extension clips, allowing not less than 2-inches height adjustment. Terminate bottom of frames at finish floor surface.
- D. Inserts, Bolts and Fasteners: Sheet metal hot-dip galvanized complying with ASTM A 153/A 153M, Class C or D as applicable.
- E. Miscellaneous Accessories:
 1. Head Strut Supports: 3/8-inch by 2-inch hot-dipped galvanized steel.
 2. Structural Reinforcing Members: Provide structural reinforcing members as part of frame assembly, where shown at mullions, transoms, or other locations that are to be built into frame.
 3. Head Reinforcing: For frames over 4 feet-0 inch wide, in masonry openings, provide continuous steel channel or angle stiffener, not less than 12-gauge for full width of opening, welded to back of frame at head.

4. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
5. Plaster Guards: 26-gauge minimum galvanized steel.
6. Louvers, Stops and Moldings: 16-gauge minimum, cold-rolled, hot-dipped galvanized, formed sheet metal.
7. Insect Screen: 14 by 18 bronze wire mesh in a rigid, formed metal frame.

2.4 FABRICATION

A. General:

1. Fabricate hollow metal units to be rigid, neat in appearance and free for defects, warp or buckle. Accurately form metal to required sizes and profiles.
2. Wherever practicable, fit and assemble units in the manufacturer's plant. Clearly identify Work that cannot be permanently factory-assembled before shipment, to assure proper assembly at the Site. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible. Filler to conceal manufacturing defects shall not be acceptable.
3. Exposed Fasteners: Unless otherwise shown or specified, do not use exposed fasteners in the Work. Where exposed fasteners are shown or specified, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.

B. Doors:

1. Fabricate all hollow metal doors and panels in compliance with ANSI A250.5.
2. Fabricate all doors with flush top and bottom closing channel, without exposed fasteners. Reinforce tops and bottoms of doors with inverted, flush-mounted, minimum 20-gauge, horizontal steel channels fastened to internal reinforcement channel and with 20-gauge closing plate spot-welded to closure channel. Close top and bottom edges to provide weather seal, as integral part of door construction or by addition of inverted steel channels and plates.
3. Hollow Metal Panels:
 - a. Fabricate hollow metal panels of the same materials, construction, and finish as specified for hollow metal doors.
 - b. Provide astragal integral with top of door where shown.
4. Edge profiles shall be provided on both stiles of doors beveled 1/8-inch in 2-inches.

C. Frame Construction:

1. Fabricate all hollow metal frames in compliance with ANSI A250.5 and as specified.
2. Fabricate frames with reinforced, mitered corners that are continuously arc-welded for the full depth and width of the frame, with bottom spreader bar; except provide drywall frames as specified.
3. Grind all exposed welds flush and smooth.

4. Mullions and Transom Bars:
 - a. Provide closed mullions and transom bars where shown. Fasten mullions and transom bars at crossings and to jambs by butt-welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.
5. Head Reinforcing: Where installed in masonry, leave vertical mullions in frames open at the top so they can be filled with grout.
6. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
7. Head Anchors: Provide two anchors at head of frames exceeding 3 foot-6 inches wide for frames mounted in drywall partitions.
8. Head Strut Supports: Provide vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
9. Rubber Door Silencers: Drill stop to receive three silencers on single-door frames and four silencers on double-door frames. Install plastic plugs to keep holes clear during construction.
10. Plaster Guards: Provide manufacturer's standard plaster guards or dust cover boxes.

D. Finish Hardware Preparation:

1. General:
 - a. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with approved Finish Hardware Schedule and templates provided by finish hardware supplier and as specified. Comply with applicable requirements of ANSI/DHI A115.1 to A115.17 and ANSI A250.4. Refer to Section 08 71 00, Door Hardware.
 - b. Obtain approved hardware schedule, hardware templates, and samples of finish hardware where necessary to ensure correct detailing and fabrication of the hollow metal doors and frames, from finish hardware supplier.
2. Doors:
 - a. Preparation includes sinkages, and cut-outs for mortised and concealed finish hardware and reinforcements for both concealed and surface-applied finish hardware.
 - b. Drill and tap mortise reinforcements at factory, using templates.
 - c. Detail and fabricate reinforcements with concealed connections designed to develop full strength of reinforcements for high-frequency applications.
 - d. Reinforce doors for required finish hardware, with minimum gauges of reinforcements provided as follows:
 - 1) Hinges: Steel plate 3/16-inches thick by 1-1/2-inches wide by 6-inches longer than hinge and secured by not less than six spot or

projection welds with top hinge further reinforced with a high-frequency back-up reinforcement.

- 2) Mortise Locksets and Dead Bolts: 12-gauge steel sheet, secured with not less than four spot or projection welds.
- 3) Flush Bolts: 12-gauge steel sheet, secured with not less than two spot or projection welds.
- 4) Surface-Applied Closers and Overhead Stops: 3/16-inch steel plate, not less than 10-inches long, secured with not less than six spot or projection welds.
- 5) Push Plates and Bars: 16-gauge steel sheet secured with not less than two spot or projection welds.
- 6) Surface Panic Devices: 16-gauge sheet steel secured with not less than two spot or projection welds.
- 7) Automatic Door Bottoms: Reinforce for mortise-type units with 14-gauge steel, and 16-gauge for surface-applied units.

3. Frames:

- a. Reinforce frames for required finish hardware with minimum gauges as follows:
 - 1) Hinges and Pivots: Special full width of frame, 3/16-inch thick steel plate by 8-inches longer than hinge, secured to both rabbets by not less than twelve spot or projection welds.
 - 2) Strike Plate Clips: 10-gauge steel plate by 1-1/2-inches wide by 3-inches long with mortar guard boxout secured with not less than six spot or projection welds.
 - 3) Surface-Applied Closers: 3/16-inch steel plate, secured with not less than six spot or projection welds. Coordinate closer function and presence of overhead stops and weather-stripping, with location of reinforcement plate.

E. Door Louvers:

1. Fabricate louvers and mount flush into doors without overlapping moldings on surface of door-facing sheets. Provide internal support as recommended by louver manufacturer. Provide profile as shown.
2. Louvers for Fire-Resistance-Rated Openings: Provide tightly fitted automatic closing, operable blades, equipped with fusible links, arranged so that metal overlaps metal at every joint, UL approved.

F. Stops and Moldings:

1. Fabricate fixed stops and moldings integral with frame. Provide fixed stops on inside of hollow metal units exposed to exterior and on corridor side of interior units.
2. Provide removable stops and molds at other locations, formed of not less than galvanized 20-gauge steel sheets. Secure with countersunk machine screws spaced uniformly not more than 12-inches on center. Form corners with butted hairline joints.

3. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated. Refer to Section 08 81 00, Glass Glazing.

2.5 SHOP PAINTING

- A. Clean, treat and paint exposed surfaces of fabricated hollow metal units, including galvanized surfaces.
- B. Clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before the application of the shop coat of paint.
- C. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC Paint 2), or basic zinc chromate-vinyl butyral solution (SSPC Paint 27).
- D. Refer to Section 09 91 00, Painting, for field-applied primer and finish paint for exterior or interior exposed ferrous, non-ferrous, or galvanized surfaces.
- E. Apply shop-coat of prime paint within time limits recommended by pretreatment manufacturer. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 1.5-mils.
- F. Finish shall be rust inhibitive primer capable of passing a 500-hour salt spray and a 1,000-hour humidity test in accordance with ASTM B 117 as certified by an independent laboratory.

2.6 SOURCE QUALITY CONTROL

- A. After Shop Drawings approval, manufacturer shall not make any further detailing, fabrication or changes to approved methods of support and anchorage, nor shall doors and frames be brought to the Site, which do not conform, in all ways, to performance criteria specified.
- B. Allowable Tolerances: Provide door and frame manufacturing tolerances in compliance with SDI 117 and as follows:
 1. Nominal Clearance between Door and Frame Head and Jamb: 1/8-inch.
 2. Nominal Clearance between Meeting Edges of Pairs of Doors: 1/8-inch.
 3. Nominal Clearance at Bottom of Door: 3/4-inch.
 4. Nominal Clearance between Face of Door and Door Stop: 1/16-inch.
 5. Provide all Work plumb and true to adjoining surfaces with all miters and copes accurately formed.
 6. Provide completely water and vapor tight joints.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the substrate and conditions under which hollow metal doors and frames are to be installed and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Frames that are bowed, twisted or otherwise unacceptable shall be removed from the Site and replaced with properly constructed frames.

3.2 PREPARATION

- A. Drilling and tapping for surface-applied, finish hardware may be done at Site.
- B. Protective Coating: Protect inside, concealed, faces of door frames in plaster or masonry construction using fibered asphalt emulsion coating. Apply over shop primer approximately 1/8-inches thick and allow to dry before installation.

3.3 INSTALLATION

- A. Install hollow metal units and accessories in accordance with approved Shop Drawings, SDI 105 and as shown and specified.
 - 1. Do not install doors and frames until all the Work, which could damage doors and frames, has been completed.
 - 2. Provide temporary doors until construction sequencing allows installation of permanent doors and frames.
 - 3. Do not proceed with the installation of permanent hollow metal doors until CONTRACTOR can provide finished Work complying with all requirements of these Specifications.
 - 4. Protect built-in frame Work with temporary wood protection.
- B. Placing Frames:
 - 1. Place frames at fire-rated openings in accordance with NFPA 80.
 - 2. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Remove spreader bars only after frames have been properly set and secured.
 - 3. Make field splices in frames as detailed on approved Shop Drawings, welded and finished to match factory work.
- C. Setting Masonry Anchorage Devices:
 - 1. In masonry construction, building in of anchors and grouting of frames is included in Section 04 05 05, Unit Masonry Construction.

2. Set anchorage devices opposite each anchor location, in accordance with details on approved Shop Drawings and anchorage device manufacturer's instructions as follows:
 - a. Masonry Walls: Install at least three jamb anchors per jamb up to 7 feet-6 inches height; four anchors up to 8 feet-0 inch jamb height; one additional anchor for each 2 foot-0 inch or fraction thereof over 8 feet-0 inch height.
 - b. Cast-In-Place Concrete and Existing Rough Openings: Anchor frame jambs with concealed bolts into expansion shields or inserts at 6-inches from top and bottom and 2 foot-0 inches on center. Apply removable stop to cover anchor bolts.
 3. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on approved Shop Drawings.
- D. Door Installation:
1. Fit hollow metal doors accurately in their respective frames, with the following clearances:
 - a. Jambs and Head: 3/32-inch.
 - b. Meeting Edges, Pairs of Doors: 1/8-inch.
 - c. Bottom: 3/4-inch, where no threshold or carpet.
 - d. Bottom: At threshold or carpet, 1/8-inch.
 2. Place fire-resistance-rated doors with clearances as specified in NFPA 80.
 3. Finish hardware installation is specified under Section 08 71 00, Door Hardware. Locate finish hardware as shown on approved Shop Drawings, in accordance with hardware templates provided by finish hardware manufacturers and in accordance with Door and Hardware Institute, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.

3.4 ADJUSTMENT AND CLEANING

- A. Check and readjust operating finish hardware items in hollow metal door and frame Work just prior to final inspection. Leave Work in complete and proper operating conditions.
- B. Where problems of installation or damage are cause for rejection of hollow metal door and frame Work, consult SDI 122 and the recommendations of the hollow metal door and frame manufacturer, for suggestions concerning required adjustments in the Work. Submit recommendations to ENGINEER for approval. Replace and repair unacceptable Work, as directed by ENGINEER, so that there will be no doubt as to the acceptability of the Work at the time of Substantial Completion.
- C. Prime Coat Touch-Up: Immediately after installation, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

- D. Protection: Protect installed hollow metal doors and frames against damage from other construction activities.

+ +END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 08 31 00

ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install all access doors and panels Work.
 - 2. Extent of access doors and panels is not shown.
 - a. Provide access doors and panels at all items buried within walls requiring access for activation or shut down: plumbing valves, cleanouts, meters, etc.
 - 3. Types of products required include the following:
 - a. Fire-rated wall access doors.
 - b. Miscellaneous hardware, accessories and fasteners.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the access doors and panels Work.
- C. Related Sections
 - 1. Section 04 00 05, Masonry.
 - 2. Section 09 26 16, Gypsum Board Assemblies.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Copies of manufacturer's technical data and installation instructions for each type of access door and panel assembly. Transmit copy of the instructions for each type to the installer. Provide setting drawings, templates, instructions and directions for installation of anchorage devices.

PART 2 - PRODUCTS

2.1 DETAILS OF CONSTRUCTION

- A. Description:

1. Provide access door and panel assemblies manufactured as integral units and complete with all components and accessories ready for installation.
- B. Fire-Rated Wall Access Doors: Provide the following for masonry and wallboard:
 1. Sandwich-Type Flush Door Panels: 20-gauge stainless steel with No. 4 finish with 2-inches of mineral wool insulation within welded pan-type construction.
 2. Frames: 16-gauge stainless steel with No. 4 finish with 1-inch wide flange continuously welded and ground smooth at corners.
 3. Finish Hardware:
 - a. Hinge: Continuous stainless steel piano hinge.
 - b. Closer: Automatic, self-latching with interior latch release.
 - c. Lock: Prepare access door for mortise locks and coordinate dead bolt and cylinder requirements with Section 08 71 00, Door Hardware.
 4. Provide fire-rated wall access doors tested and approved by Underwriters' Laboratories, Inc., for sixty-minute fire-resistance.
 - a. New gypsum wallboard assemblies in Odor Control Equipment Room are 120-minute rated assemblies. Total wall assembly is 4-hour rated assembly.
 5. Size: 16-inches by 16-inches.

2.2 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 1. Karp Associates, Inc.
 2. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR must examine the areas and conditions under which access doors are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

- A. Comply with manufacturer's instructions for installation of access doors and panels.
- B. Coordinate installation with work of other trades.
- C. Set frames accurately in position and securely attach to support with face panels plumb or level in relation to adjacent finish surfaces.

3.3 ADJUSTMENT AND CLEANING

- A. Adjust hardware and panels after installation for proper operation.
- B. Remove and replace panels or frames, which are warped, bowed or otherwise damaged.

+ + END OF SECTION + +

++NO TEXT ON THIS PAGE++

SECTION 08 51 13

ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all aluminum windows Work.
2. Extent of the aluminum windows is shown and specified.
3. Types of products required include the following:
 - a. Custom High Performance Insulated Thermal-Barrier Aluminum Windows:
 - 1) Project-in thermal barrier operable assemblies within fixed aluminum windows.
 - 2) Fixed thermal barrier aluminum windows.
 - 3) Tubular muntins and intermediates providing true divided lites, mullions and all custom accessories and fasteners.
 - 4) Gaskets, pressure plates and snap covers in conjunction with each of the above components.
 - 5) Intermediate mullions and all accessories and fasteners.
 - 6) Hardware, custom panning and miscellaneous materials.
 - 7) Anchors, inserts, support brackets, expansion devices, fasteners, flashings, weeps, and similar elements in conjunction with each of the above components.
 - b. Complete selection of custom and premium custom-blended full-strength polyvinylidene fluoride finishes and colors with extended life topcoat.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the aluminum windows Work.

C. Related Sections:

1. Section 08 81 00, Glass Glazing.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Architectural Manufacturer's Association, (AAMA).
 - a. AAMA 101, Voluntary Specifications for Aluminum Prime Windows and Sliding Glass Doors.

- b. AAMA 302.8, Specification for Aluminum Windows.
 - c. AAMA 701-702, Voluntary Specification for Pile Weatherstrip and Replaceable Fenestration Weatherseals.
 - d. AAMA GS-001, Guide Specifications for Aluminum Architectural Windows.
- 2. American Society for Testing and Materials, (ASTM).
 - a. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
 - b. ASTM B 221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - c. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
 - d. ASTM D 523, Test Method for Specular Gloss.
 - e. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
 - f. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - g. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
 - h. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
 - i. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
 - j. ASTM E 283, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - k. ASTM E 330, Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - l. ASTM E 331, Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference.
- 3. Federal Specification, (FS).
 - a. FS RR-W-365, Wire Fabric.
- 4. National Association of Architectural Metal Manufacturers, (NAAMM).
 - a. NAAMM Metal Finishes Manual for Architectural and Metal Products.
- 5. Uniform Building Code, (UBC).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

- 1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Installer's Qualifications:

- 1. Installer shall be certified by the manufacturer of the aluminum windows to

install the product accepted for this Project. Installer shall provide evidence of at least five years installing similar product to the product accepted for this Project as well as at least three references for projects where the exact product accepted for this Project has been successfully installed.

2. Submit name and qualifications of the installer to the ENGINEER.

C. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of the component manufacturer from a single aluminum window manufacturer.
2. The aluminum window manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the aluminum window manufacturer.

D. Mock-Ups:

1. Prior to the installation of custom aluminum window system with Project operable vent and accessories, but after ENGINEER'S approval of Samples and Shop Drawings, install sample of custom aluminum window system with Project operable vent, in an area selected by ENGINEER to show a representative installation of the Work. Obtain ENGINEER'S acceptance of visual qualities of the mock-up before start of the Work. Retain and protect mock-up during construction as a standard for judging completed custom aluminum window system with Project operable vent Work. Do not alter mock-ups, unless given written permission by ENGINEER.
2. Work that does not meet the standard approved on the sample areas shall be removed and replaced with new material, as required by ENGINEER.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Fabrication and installation of aluminum window units and associated components of the Work. Include wall elevations at 1/4-inch scale, typical unit elevations at 1-inch scale and full-size detail sections of every typical composite member. Show anchors, hardware, operators and other components not included in manufacturer's standard data, including glazing details. Indicate clearly on the Shop Drawings, all deviations from Contract Documents.
2. Product Data:
 - a. Copies of manufacturer's specifications, recommendations and standard details for aluminum window units, including fabrication, finishing, hardware and other components of the Work. Include certified test laboratory reports as necessary to show compliance with the requirements.

- b. Copies of manufacturers' specifications and installation instructions for required materials and components, which are not included in the other submittals, specified in other Sections of these Specifications.
Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.
 - 3. Samples:
 - a. Samples of each required aluminum color and finish, on 12-inch long sections of extrusion shapes as required for the aluminum window units.
 - b. Samples will be reviewed by ENGINEER for color and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.
- B. Informational Submittals: Submit the following:
 - 1. Test and Evaluation Reports: Certified laboratory test reports for required performance tests.
 - 2. Qualification Statements:
 - a. Installer
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Documentation: Upon completion of the Work, furnish five copies of detailed maintenance manual including the following information:
 - a. Product name and number.
 - b. Name, address, e-mail address and telephone number of manufacturer and local distributor.
 - c. Detailed procedures for routine maintenance and cleaning.
 - d. Detailed procedures for light repairs such as dents, scratches and staining.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and

repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Design Criteria:

1. Except as otherwise shown or specified, the requirements for aluminum windows, and the terminology and standards of performance and fabrication workmanship, are those specified and recommended in AAMA 101, and the applicable general recommendations published by Architectural Aluminum Manufacturer's Association, National Association of Architectural Metal Manufacturers and Aluminum Association.
2. All custom and standard features and finishes offered by the named manufacturer shall be made available to ENGINEER from any "or equal" manufacturer submitted by CONTRACTOR.
3. Custom High Performance Insulated Thermal-Barrier Aluminum Windows:
 - a. Performance and Testing: Except as otherwise specified, comply with the air infiltration tests, water resistance tests and applicable load tests specified in AAMA 101 for the type and classification of aluminum window units required in each case.
 - b. Comply with Architectural Performance Class and Section 4 "Optional Performance Grades" of AAMA 101 Group II-Compression Seal Window Products AP-AW50, Architectural.
 - c. Design Pressure:
 - 1) Provide uniform structural test pressure of 75 pounds per square foot.
 - 2) Air Infiltration Test, ASTM E 283: Maximum infiltration 0.065 cubic feet per minute per linear foot of operating ventilator when tested at 6.24 pounds per square foot differential pressure.
 - 3) Water Penetration Test, ASTM E 331: No water penetration for 15 minutes when window is subjected to rate of flow of five gallons per hour per square foot with differential pressure across window unit of ten pounds per square foot.
 - 4) Wind Load Test, ASTM E 330: Minimum 50 pounds per square foot positive and negative load for ten seconds. Maximum deformation of frame or sash member L/175 of span length.
 - d. Testing: Wherever manufacturer's standard window units comply with the requirements and have been tested in accordance with the specified tests, provide certification by the manufacturer of compliance with such tests; otherwise, perform the required tests through a recognized testing laboratory or agency and provide certified test results.
 - e. Provide internal drainage to lead all infiltrated water to the exterior through weep slots.

- f. Other Loading: Applicable requirements of the 2016 Connecticut State Building Code.

2.2 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. Traco Architectural Systems, Inc.
 - 2. Or equal.

2.3 DETAILS OF CONSTRUCTION

- A. Aluminum Extrusions: Alloy and temper, ASTM B 221, 6063-T5 and not less than 1/8-inch thickness at any location for mainframe sash members and tube supports. Vertical mullions and support clips as recommended by the window manufacturer.
- B. Thermal Separator: Interior and exterior aluminum frame sections shall be thermally separated by a continuous urethane connector.
- C. Fasteners: Stainless steel, guaranteed by the manufacturer to be non-corrosive and compatible with the aluminum window members, trim, hardware, anchors and other components of the window units.
 - 1. Do not use exposed fasteners, except where unavoidable for the application of hardware. Match the finish of the metal surrounding the fastener, unless otherwise specified.
 - 2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise specified.
- D. Glazing Gaskets: Neoprene or EPDM.
- E. Glass and Glazing Materials: Refer to Section 08 81 00, Glass Glazing.
- F. Wire Fabric Insect Screen: 18 by 14 mesh of 0.01-inch diameter aluminum wire, complying with FS RR-W-365, Type VII.
- G. Hardware:
 - 1. Projected-In Windows: Mullion mounted high-pressure die-cast zinc nickel-plated steel pawl cam-action in-line base locking handles with concealed pawl. Provide non-magnetic stainless steel keepers. Baked enamel aluminum color with lacquer finish.
 - 2. Heavy-duty 6-bar hinges with stainless steel balance arms. Provide sliding pivots with nylon friction-adjustable shoe in a stainless steel track.
 - 3. Concealed limited opening device.
 - 4. Manufacturer: Provide the product of the following:
 - a. Truth Division Sealed Power Corporation.

2.4 WINDOW OPERATION

- A. General: The following paragraph defines the operating arrangement for the required types of sash (ventilators) in window units, and specifies minimum provisions for each type.
 - 1. Project-in Windows: Swing-in, and fixed window combinations as shown, provide operable sash with two balance-support arms, pivots with friction shoes and three cam handle operators; top mounted cam handles for pole operation.

2.5 WINDOW CLASSIFICATION (GRADE)

- A. AP-AW50, Architectural Windows: Provide window units complying with the following:
 - 1. Extruded aluminum-glazing stops of 0.062-inch minimum wall thickness, except 0.050-inch minimum for snap-on type.
 - 2. Hardware and anchors of non-magnetic stainless steel and white bronze.
 - 3. Fabricate units with all main corners and intersections of frame and sash mitered. Provide double tubular frame with hydraulically crimped gusset corner construction. Mortise or cope secondary members to fit, and weld in place with hairline joints.
 - 4. Provide metal thickness as required to withstand performance requirements, but not less than 0.078-inch for frame members.
 - 5. Provide means of drainage for water and condensation, which may accumulate in members of the window units.

2.6 FABRICATION AND ACCESSORIES

- A. General: Provide specified manufacturer's standard fabrication and accessories, except to the extent more specific or more stringent requirements are specified. Include complete system for assembly of components and anchorage of window units, and prepare sash for glazing.
- B. Sizes and Profiles: The required sizes for window units and the profile requirements are shown. The details shown are based upon standard details by one or more manufacturers. It is intended that similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/ maximum profile requirements specified.
- C. Coordination of Fabrication: Wherever possible check actual window openings in the construction Work by accurate field measurement before fabrication, and show recorded measurements before fabrication, and show recorded measurements on final Shop Drawings. However, coordinate fabrication schedule with construction progress as directed by CONTRACTOR to avoid delay of the Work. Where necessary, proceed with fabrication without field measurements, and coordinate installation tolerances to ensure proper fit of window units.

- D. Provide mullions and cover plates as shown, matching window units and complete with anchors for support to structure and for installation of window units. Allow for erection tolerances and provide for movements of window units due to thermal expansion and building deflections.
- E. Provide insect screen unit for each operable exterior sash. Locate screen units on outside of sash. Wherever possible, design window units and hardware to accommodate screens in a tight-fitting removable arrangement, with a minimum of exposed fasteners and latches, and with aluminum-extruded frame continuous wickets along lower edge of screen for cam handle access.
- F. Fabricate screen frames of extruded aluminum tubular-shaped members of 0.040-inch minimum wall thickness, with mitered or coped joints and concealed mechanical fasteners, with removable PVC spline-anchor concealing the edge of the screen fabric, and finished to match the window unit, unless otherwise indicated.
- G. Provide serrated sash for pre-shimmed glazing tape.
- H. Provide extruded aluminum true-divided mullions, and custom aluminum panning as shown.

2.7 ALUMINUM WINDOW FINISHES

- A. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded or factory-fabricated material. Provide a four-coat system complying with the following:
 - 1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
 - 2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold-water rinse. Seal with a chromic acid rinse and dry, except where manufacturer recommends another method to achieve greater coating reliability.
 - 3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.2 to 0.4-mils. Follow with a barrier coat 1.0-mils thick.
 - 4. Apply color coat containing mica pearlescent or metallic flakes over the barrier coat by roller coating for coil material and airless or Ransburg Elastostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440°F for a dry film thickness of 0.7-mils for coil coating and 1.2-mils for spray coating so that today dry film is approximately 1.0-mil thick for coil material and 1.5-mil thick for extruded material.
 - 5. Apply clear fluoropolymer topcoat to provide a dry film thickness of 0.4 to 0.8-mils. The entire system shall have a dry film thickness of 2.6-mils, minimum.

6. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to ENGINEER:
 - a. Weathering, ASTM D 4214: Chalking, not more than No. 8, after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
 - b. Color Change, ASTM D 2244: No greater than 5 N.B.S units after removal of external deposits and after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
 - c. Humidity Resistance, ASTM D 2247: No blister after 3,000 hours.
 - d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16-inch creep from areas scribed to bare metal after 3,000 hours.
 - e. Dry Adhesion: No pick-off when tape tested over 1/16-inch cross hatch.
 - f. Wet Adhesion: No pick-off when tape tested over 1/16-inch cross hatch; extruded material only.
 - g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after one-hour immersion in distilled boiling water.
 - h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water $80 \pm 10^{\circ}\text{F}$ after 500 hours.
 - i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67, minimum.
 - j. Gloss, ASTM D 523: 30 ± 5 reflectivity at 60°F .
 - k. Pencil Hardness, ASTM D 3363: HB-H minimum.
 - l. Dry Film Thickness: Primer, 0.2 to 0.4-mils, barrier coat, 1.0-mils, color coating, 0.7 to 1.5-mils; clear topcoat, 0.4 to 0.8-mils.
 - m. Solvent Resistance: 100 Double MEK rubs, minimum.
 - n. Flexibility, ASTM D 522: No cracking prior to metal fracture.
 - o. Acid Resistance, ASTM D 1308: Sixteen hour spot test with five percent hydrochloric acid - no effect.
 - p. Alkali Resistance, ASTM D 1308: Sixteen hour spot test with five percent sodium hydroxide - no effect.

B. Color:

1. Full selection of manufacturer's standard, custom and premium colors for final selection by ENGINEER.
2. ENGINEER will select custom special extended life premium colors for aluminum windows at time of Shop Drawing and sample submission review.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the substrate and conditions under which custom aluminum window system Work is to be installed and notify ENGINEER, in

writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

- A. Comply with manufacturer's specifications, installation manuals and recommendations for the installation of window units, hardware, operators, and other components of the Work.
- B. Erection Tolerances:
 - 1. Limit variations from plumb, level or dimensioned angle to the following:
 - a. 1/8-inch maximum deviation in story height or in 10-foot vertical or angular run, and in 20-foot horizontal runs.
 - b. 1/4-inch maximum deviation in 40 foot runs, all directions.
 - 2. Limit variations from theoretical member locations shown, based on established floor lines and column lines, including variations from plumb and level, to the following:
 - a. 3/8-inch total maximum deviation for members at all locations.
 - b. 1/8-inch maximum change in deviation for members for ten foot runs, all directions.
 - 3. Limit offsets in end-to-end and edge-to-edge alignments of adjoining and consecutive members, which form planes, continuous runs and profiles, to the following:
 - a. 1/16-inch maximum offset in flush alignment, including members, which are to be 1/2-inch or less out-of-flush, and including members, which are separated 2-inches or less by a reveal or protrusion in the plane of the aluminum window wall.
 - b. 1/8-inch maximum offset in alignments, which are to be out-of-flush by more than 1/2-inch, or separated by a reveal or protrusion of more than 2- inch width.
- C. Anchor units securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- D. Refer to Section 07 92 00, Joint Sealants, for compounds, fillers and gaskets to be installed concurrently with window units.
- E. Do not install component parts, which are observed to be defective in any way, including warped, bowed, dented, abraded and broken members, and including glass with edge damage.
- F. Do not cut, or trim, component parts during erection, in a manner, which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance of the aluminum window wall. Return component parts,

which require alteration to the shop for refabrication, if possible, or for replacement by new parts.

- G. Install component parts level, plumb, true to line and with uniform joints and reveals. Secure to structure with non-staining and non-corrosive shims, anchors, fasteners, spacers and fillers. Use erection equipment, which will not mar or stain finished surfaces, and will not damage the component parts.
- H. Apply a bituminous coating of approximately 30-mil dry film thickness, or other suitable permanent separator, on concealed contact surfaces of dissimilar materials before installation, wherever there is the possibility of corrosive or electrolytic action.
- I. Anchor component parts securely in place as shown, by bolting, or other permanent mechanical attachment system, which will comply with performance requirements and permit movements, which are intended or necessary. Install slip-joint linings to ensure movement as intended or necessary.
- J. Clean debris, dust and other substances from behind the aluminum window wall as it is erected, and provide temporary closures if necessary to prevent the accumulation of such substances in the void spaces behind the aluminum window walls.
- K. Install thermal barrier between pressure plate and mullion.
- L. Attach pressure plate with screws. Install snap covers over pressure plates.
- M. Install glazing using dry glazing retainers, which provide a firm but resilient clamping grip on the glazing.
- N. Adjust operating sash and hardware to provide a tight fit at contact points and at weatherstripping for smooth operation and weathertight closure.
- O. Refer to Section 08 81 00, Glass Glazing, for installation requirements.
- P. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage of the finish. Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts.
- Q. Advise CONTRACTOR of protective treatment and other precautions required through the remainder of the construction period, to ensure that window units will be without damage or deterioration, other than normal weathering, at the time of Final Completion.
- R. Maintain the aluminum window wall in a clean condition throughout the construction period, so that it will be without any evidence of deterioration or damage, other than the effects of normal weathering, at the time of Final Completion. Select methods of cleaning which will promote the achievement of

uniform appearance and stabilized colors and textures for materials that weather or age with exposure.

- S. CONTRACTOR shall advise ENGINEER, in writing, of protection and surveillance requirements that CONTRACTOR shall provide at no additional cost to the OWNER, to ensure that the aluminum windows Work will be without deterioration or damage at the time of Final Completion by OWNER.
- T. Remove and replace with new material aluminum window components, which have been damaged, including finish, beyond successful repair, as directed by ENGINEER. Repair minor damage.
- U. Immediately before the time of Final Completion, clean the aluminum windows thoroughly, inside and out. Demonstrate proper cleaning methods to OWNER'S maintenance personnel during this final cleaning.
- V. At the completion of the Work, clean or replace adjacent work, marred by the Work of this Section.
- W. Remove all materials and debris and leave the Site of the Work in clean condition.

3.3 FIELD QUALITY CONTROL

- A. Water Penetration Test: Perform test in accordance with NAAMA Standard FC-1: "Field Check for Water Leakage of Metal Curtain Walls", except limit test area to one bay wide (but not less than 20 feet or more than 40 feet) by one story high, located from mid-bay to mid-bay and from mid-story-height to mid-story-height.
- B. Depending upon the prevalence or absence of leakage in the initial water penetration test, and upon measures adopted by the aluminum window wall CONTRACTOR to eliminate sources of leakage from subsequently erected work, the ENGINEER will determine the necessity, and scope of, additional tests. In no case will the total of tested area amount to less than one percent, nor more than ten percent of the aluminum window wall area, except as subsequently authorized by the ENGINEER.

+ + END OF SECTION + +

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install door hardware. Furnish door hardware for all doors in compliance with these Specifications herein.
2. Extent of door hardware is specified. Door hardware is defined to include all items known commercially as door hardware, except special types of unique and non-matching hardware specified in the same Section as the door and door frame.
3. Types of products required include the following:
 - a. Mortise hinges.
 - b. High-security mortise locksets.
 - c. High-security mortise latchsets.
 - d. Panic exit devices.
 - e. Overhead, surface-mounted, door closers.
 - f. Extra heavy-duty, surface-mounted, overhead holders and stops.
 - g. Flush bolts.
 - h. Astragals.
 - i. Dust-proof strikes.
 - j. Stripping and seals.
 - k. Thresholds.
 - l. Silencers.
 - m. Floor stops.
 - n. Wall stops.
 - o. Miscellaneous items and accessories for a complete installation functioning in compliance with the requirements of governing authorities having jurisdiction at the Site.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the door hardware.
2. Coordinate the Work of other Sections to provide clearances and accurate positioning of recessed or cast-in-place items.

C. Related Sections:

1. Section 08 11 13, Hollow Metal Doors and Frames.
2. Section 08 31 00, Access Doors and Panels.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
1. American National Standards Institute, (ANSI).
 - a. ANSI A117.1, Accessible and Usable Buildings and Facilities.
 2. American National Standards Institute, (ANSI), in association with Builders Hardware Manufacturers' Association, (ANSI/BHMA).
 - a. ANSI/BHMA A156.1, Butts and Hinges.
 - b. ANSI/BHMA A156.3, Exit Devices.
 - c. ANSI/BHMA A156.4, Door Controls - Closers.
 - d. ANSI/BHMA A156.6, Architectural Door Trim.
 - e. ANSI/BHMA A156.7, Template Hinge Dimensions.
 - f. ANSI/BHMA A156.8, Door Controls - Overhead Stops and Holders.
 - g. ANSI/BHMA A156.13, Mortise Locks and Latches, Series 1000.
 - h. ANSI/BHMA A156.16, American National Standard for Auxiliary Hardware.
 - i. ANSI/BHMA A156.18, Hardware - Materials and Finishes.
 - j. ANSI/BHMA A156.21, Thresholds.
 - k. ANSI/BHMA A156.22, Door Gasketing and Edge Seal Systems.
 3. ANSI, in association with Door and Hardware Institute, (ANSI/DHI).
 - a. ANSI/DHI A115.1, Preparation of Mortise Locks in 1-3/8-inch and 1-3/4-inch Standard Steel Doors and Frames.
 4. ANSI, in association with National Fire Protection Association, (ANSI/NFPA).
 - a. ANSI/NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
 5. ANSI, in association with Underwriters' Laboratories, Inc., (UL).
 - a. UL 10B, Fire Tests of Door Assemblies.
 6. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG).
 7. Door and Hardware Institute, (DHI).
 - a. DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
 - b. DHI, Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.
 - c. DHI, Sequencing and Format for the Hardware Schedule.
 8. Hollow Metal Manufacturers Association, Division of National Association of Architectural Metal Manufacturers, (HMMA).
 - a. HMMA 830, Hardware Preparation and Locations for Hollow Metal Doors and Frames.
 9. National Fire Protection Association, (NFPA).
 - a. NFPA 80, Fire Doors and Fire Windows.
 10. Steel Door Institute, (SDI).
 - a. SDI 109, Hardware for Standard Steel Doors and Frames.
 - b. SDI 118, Basic Fire Door Requirements.
 11. Underwriters' Laboratories, Inc., (UL).
 - a. UL 305, Panic Hardware.
 - b. UL, Building Materials Directory.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Provide door hardware and accessories manufactured by firms specializing in the production of this type of Work and complying with specified standards of ANSI, BHMA, DHI, NFPA, HMMA, SDI and UL.
2. Provide door hardware from manufacturers who are members of BHMA and participate in BHMA certification programs.

B. Installer's Qualifications:

1. The door hardware installer shall have in his employ an architectural hardware consultant. The architectural hardware consultant shall be a member of the Door and Hardware Institute, (DHI), who has passed the DHI certification examine and successfully completed an apprenticeship program. The architectural hardware consultant shall be responsible for preparing door hardware schedules and Shop Drawings and be present at the Site for the purpose of checking and supervising the Work of the installer during the time of installation and adjustment of the door hardware Work, and shall prepare a written field report on status of completed door hardware installation as specified.
2. Submit name and qualifications of the installer to ENGINEER.

C. Requirements of Regulatory Agencies:

1. Provide door hardware for fire-resistance-rated openings in compliance with NFPA 80.
2. Provide only door hardware that has been tested, listed and labeled by UL for the types and sizes of doors required, and complies with the requirements of the door and door frame labels.
3. Modify features of door hardware items specified, and provide additional accessories and features as required to meet UL and NFPA requirements, at no additional cost to the OWNER.

D. Codes: Comply with applicable requirements of codes.

E. Source Quality Control:

1. Obtain each type of door hardware item from only one manufacturer.
2. Provide door hardware schedule, for submission to, and for approval by, ENGINEER, prepared in compliance with DHI standards.
3. Comply with specified BHMA standards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Copies of manufacturer's data for each item of door hardware. Include whatever information may be required to show compliance with specified requirements, and include instructions for installation and for

maintenance of operating parts and exposed finishes. Include mounting heights and locations for each item of door hardware. Provide ENGINEER with latest complete technical catalogue of all available door hardware manufactured by proposed manufacturers, even if manufacturer specified by ENGINEER is submitted by CONTRACTOR to perform the Work. Furnish templates to fabricators of other Work, which is to receive door hardware.

2. Shop Drawings:

- a. Copies of the Door Hardware Schedule in the manner and format specified, complying with the actual construction Progress Schedule requirements (for each draft). Include explanation of abbreviations, symbols, and codes used to present scheduled information.
 - 1) Prepare and submit Door Hardware Schedule in compliance with HDI standards.
- b. Based on the door hardware requirements specified, organize the final Door Hardware Schedule into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other Work (such as hollow metal frames) which may be critical in the Project Schedule. Furnish final draft of schedule after Samples, manufacturer's data sheets, coordination with Shop Drawings for other Work, delivery schedules and similar information have been completed and accepted.
- c. Include a separate key schedule, showing clearly how OWNER'S final instructions on keying of locks have been fulfilled.
- d. Door Hardware Schedules are intended for coordination of the Work. Review and acceptance by ENGINEER does not relieve CONTRACTOR of responsibility to fulfill the requirements as shown and specified.

2. Samples: Submit the following:

- a. Actual unit of each door hardware item specified incorporating all standard and special features and finishes specified, demonstrated and identified by manufacturer's representative to ENGINEER. Samples shall be presented at time of Shop Drawing submittal, as ENGINEER will not review or approve Shop Drawings without concurrent sample submissions.
- b. Approved samples may be incorporated into the door hardware Work.
- c. ENGINEER'S review will be for appearance and for general compliance with required features. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Informational Submittals: Submit the following:

1. Test and Evaluation Reports:
 - a. Certified independent laboratory test reports for BHMA certification program and certification tests for each type of product specified.
2. Qualifications Statements:
 - a. Installer.

- C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Documentation: Upon completion of the Work, furnish five copies of detailed maintenance manuals, including the following information:
 - a. Product name and manufacturer.
 - b. Name, address, e-mail address and telephone number of manufacturer and local distributor.
 - c. Detailed procedure for routine maintenance and cleaning.
 - d. Detailed procedures for repairs such as dents, scratches and staining.
 - e. Parts identification manual and maintenance manuals for each piece of door hardware.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
 2. Deliver all items of door hardware in manufacturer's original, undamaged packages, bearing accurate representation of the item within each package.
 3. Pack each piece of door hardware separately, complete with screws, keying, instructions and templates, tagged to correspond with items submitted on approved Shop Drawings and as specified.
- B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Provide secure storage area for door hardware items, secured by locks and accessible only to door hardware installer, ENGINEER and CONTRACTOR.
 3. Store door hardware in manufacturers' original packages.
- C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Items that arrive in a damaged condition shall be removed from the Site and not offered again for acceptance. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Description:

1. Where the door, shape, size, fire-resistance-rating, frequency of use, or function of a member receiving door hardware is such as to prevent, or make unsuitable, the types of door hardware specified, furnish similar types having as nearly as practicable the same operation but of type or kind more appropriate to the design intension and requirements of governing authorities having jurisdiction at the Site. Clearly identify and highlight to ENGINEER all such required modifications on Shop Drawings submitted for approval.
2. If door hardware for any location is not specified, provide door hardware equal in design and quality to adjacent door hardware specified for comparable openings at no additional cost to OWNER.
3. Furnish door hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements, as necessary for proper installation and function.
4. Unless otherwise specified, comply with DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames and Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.

2.2 DETAILS OF CONSTRUCTION

A. General:

1. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of door hardware for proper installation and operation of the door swing as shown.
2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with labels required by governing authorities having jurisdiction at the Site.
3. Base Metals: Produce door hardware units of the basic metal and forming method specified, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not substitute materials or forming methods for those specified.
4. Fasteners: Manufacture door hardware to conform to published templates, generally prepared for machine screw installation. Do not provide door hardware, which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
5. Furnish screws for installation, with each door hardware item. Provide Phillips flat-head screws except as otherwise specified. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces on other Work, to match the finish of such other Work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
6. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of door hardware, base material or fastener.
7. Provide concealed fasteners for door hardware units, which are not exposed when the door is closed, except to the extent no standard manufacturer units of the type specified are available with concealed fasteners. Do not use through

bolts for installation where the bolt head or the nut on the opposite face is exposed in other Work under any condition, except where it is not possible to adequately reinforce the Work and use machine screws or concealed fasteners of another standard type to satisfactorily avoid the use of through bolts.

8. Tools for Maintenance: Furnish two complete sets of specialized tools as required for OWNER'S continued adjustment, maintenance, removal and replacement of door hardware.

B. Mortise Hinges:

1. Templates and Screws: Provide only template-produced units.
2. Base Metal: Except as otherwise specified, fabricate hinges from stainless steel and finish to match the latch and lock set.
3. Number of Hinges: Provide three hinges on each door leaf of less than 60-inches in height; provide one additional hinge for next 30-inches of door height or fraction thereof; provide two additional hinges for each 30-inches, or fraction thereof, for doors above 90-inches tall.
4. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
 - a. Interior Doors:
 - 1) Heavy Use, Maximum 36-Inches Wide: 4-1/2-inch heavy-weight (0.180-inches).
 - b. Exterior Doors, Maximum 36-Inches Wide: 4-1/2-inch heavy-weight (0.180-inch).
 - c. Wide Exterior and Interior Doors:
 - 1) Maximum 48-inches wide: 5-inch heavyweight (0.190-inch).
 - 2) Over 48-inches wide: 6-inch heavy weight (0.203-inch).
5. Types of Hinges: Provide full-mortise type, ball-bearing hinges, swaged for mortise applications, inner leaf beveled, square cornered, unless manufacturer's recommendations indicate that half-mortise, half-surface, full-surface or other type should be used for the frame and door type or condition.
6. Hinge Pins: Except as otherwise specified, provide hinge pins as follows:
 - a. Pins: Stainless steel.
 - b. Exterior Doors: Non-removable pins. Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.
 - c. Tips: Slope ends of hinge barrel.
7. Conform to ANSI/BHMA A156.7.
8. Comply with UL, List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
9. Products and Manufacturers: Provide one of the following:
 - a. FBB 199 and FBB 191 by Stanley Commercial Hardware, Division of The Stanley Works.
 - b. T4B3386 and TB3313 by McKinney Products Company, Division of ESSEX Industries, Incorporated.
 - c. Or equal.

C. High-Security Mortise Locks and Latch Sets:

1. Strikes: Provide manufacturer's standard wrought box strike, for each location and use shown. Provide stainless steel curved lip strikes, unless otherwise recommended by manufacturer, finished to match lock or latch set trim.
2. Lock Throw: Provide minimum of 3/4-inch anti-friction latch bolt and 1-inch dead bolt throw. Comply with UL requirements for throw of latch bolts and deadbolts on fire-resistance-rated openings.
3. Materials: Provide the following features and materials:
 - a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
 - b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
 - c. Case: Wrought steel, zinc dichromatized.
 - d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
 - e. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
 - f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
 - g. Hubs: Sintered steel, copper infiltrated.
 - h. Lever with Stop Pin: Brass, plated to match stainless steel, with additional built-in stop to prevent over-torquing of lever.
 - i. All components shall be of marine quality, wherever possible.
4. Backset: 2-3/4-inches.
5. Modify specified locks and latches to comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
6. Finish: US 32D satin.
7. Conform to ANSI/BHMA A156.13, Series 1000, Security Grade 1.
8. Products and Manufacturers: Provide one of the following:
 - a. High Security SL8700 Mortise Lockset Augusta - ASL Lever Handles and Trim by Yale Security, Incorporated, Division of Yale Security Group.
 - b. Or equal.

D. Panic Exit Devices:

1. Exit Doors: Where required by governing authorities having jurisdiction at the Site, provide panic exit devices, of the type required, including UL labels.
2. Fire Doors: Where shown or specified as a fire-resistance-rated door, provide units listed and labeled by UL, to comply with the fire-resistance-rating and size of door shown.
3. Strikes: Provide manufacturer's standard wrought stainless steel jamb-mounted top latch bolt and bottom latch bolt for each location and use shown to allow independent opening and closing of each leaf of double doors with panic exit devices; complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
4. Lock Throws: Provide minimum of 3/4-inch latch bolt throw complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.

5. Provide concealed vertical rod type exit device and mortise type exit devices as specified.
 6. Provide the following features and materials:
 - a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
 - b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
 - c. Case: Wrought steel, zinc dichromatized.
 - d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
 - e. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
 - f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
 - g. Hubs: Sintered steel, copper infiltrated.
 - h. Crossbar: Oval, seamless with interlocking expansion collets and roll pins; knurled, satin stainless steel, 0.062-inches minimum thickness, with steel reinforcing tube.
 - i. Concealed bolts: Minimum 1/2-inch diameter, stainless steel.
 7. Backset: Provide minimum backset of 2-3/4-inches.
 8. Finish: US 32D satin.
 9. ANSI/BHMA: A156.3, Type 3 and Type 8, Grade 1; F08, entrance by lever, key locks or unlocks lever for entrances shown as accessible to people with disabilities as required by ADAAG; and F05, entrance by thumb piece, key locks or unlocks thumb piece.
 10. Products and Manufacturers: Provide one of the following:
 - a. 1530-L8 (F) and -T8 (F) Series Mortise Exit Devices and 1520(F) CVR Concealed Vertical Rod Exit Devices; with Escutcheon Trim and Augusta - ASL Lever Handles and Thumbpiece/Handle/Cylinder Unit by Yale Security, Incorporated, Division of Yale Security Group.
 - b. Or equal.
- E. Cylinders and Keying System:
1. Review the keying system with OWNER'S and provide the type required (master, grandmaster or great grandmaster), either new or integrated with OWNER'S existing system.
 2. Furnish all locks with manufacturer's cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these before Substantial Completion. Construction control keys and cores shall not be part of OWNER'S permanent keying system. Permanent cores and keys shall be furnished to OWNER prior to Substantial Completion.
 3. Comply with the OWNER'S instructions for master keying and, except as otherwise specified, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.
 4. Permanent keys and cores shall be stamped with the applicable key mark for identification. These visual key control marks or codes shall not include the actual key cuts. Permanent keys shall also be stamped "DO NOT DUPLICATE".
 5. Cylinder Material: Brass, bronze or Series 300 stainless steels.

6. Cylinder Features: Seven-pin, high-security, removable core.
7. Key Material: Nickel silver.
8. Key Quantity: Furnish one key for each lock and five keys for each master and grandmaster system. Provide one extra key blank for each lock.

F. Overhead, Surface-Mounted, Door Closers:

1. Provide all doors, with surface-mounted overhead door closers. Provide both active and inactive door leafs with closers.
2. Size of Units: Except as otherwise specified, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.
3. Where parallel arms are specified, and for closers on exterior doors, provide closer unit one size larger than recommended for use with standard arms.
4. Use parallel arm arrangement for doors that would otherwise have the door closer appearing in finished corridors or entries.
5. Comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials, and NFPA 80. Modify closers specified as required.
6. Provide hold open feature for all non-fire-resistant-rated doors, unless otherwise specified.
7. Provide corner bracket mounting on exterior doors. Select all arms to clear weather-stripping, and overhead door holders.
8. Provide long arm to allow door to swing 180 degrees where long arm will eliminate floor-mounted stops.
9. Provide closers with spring power adjustment feature capable of increasing spring power 15 percent minimum in all closer sizes.
10. Provide individual regulating valves for closing and latching speeds, and separate adjustable back check valve.
11. Provide delayed closing action feature on all door closers. Position valve at top of closure.
12. Provide the following materials and features:
 - a. Full Metal Cover: Aluminum.
 - b. Case: Cast-iron.
 - c. Arms: Plated to match full metal covers.
 - d. Other Parts: Steel.
 - e. Extreme temperature fluid.
 - f. Security torx machine screws.
 - g. Ten-year warranty.
 - h. Provide manufacturer's optional corrosion protection.
13. Finishes: US 26D satin chrome. Color coordinate all arms and other accessories.
14. Highly Corrosive Atmospheres: Provide all closers with specified manufacturer's optional corrosion protection.
15. ANSI/BHMA: A156.4, C02011, in compliance with PT 1 and PT 4.
16. Products and Manufacturers: Provide one of the following:
 - a. DC2000DA M71, M73, M74, M75, M87 by Corbin Russwin, Incorporated, Division of Yale Security Group.

b. Or equal.

G. Extra Heavy-Duty Overhead Holders and Stops:

1. Provide surface-mounted, extra heavy-duty overhead holders and stops with hold-open feature for doors included in List of Door Hardware Items at end of Part 3.
2. Materials: Provide the following materials:
 - a. Arm: Type 316 stainless steel, 3/4-inch diameter rod minimum.
 - b. All Other Parts: Extruded brass.
3. Coordinate placement of extra heavy-duty overhead holder and stop with weather-stripping for non-interference. Provide angle jamb brackets as required to mount to surfaces encountered in the Work. Coordinate and provide additional drop-brackets for non-interference with overhead closer mounting.
4. Design and reinforce connections of extra heavy-duty holder and stops where they are fastened to other materials, to resist a superimposed load of 30 pounds per square foot acting on the plane of the doors. Mount to door using a minimum of four countersunk mounting holes with four 5/16-inch diameter stainless steel pan head machine screws.
5. Provide all manufacturer recommended door reinforcements and coordinate the furnishing of hardware templates required for the installation of the units.
6. Finish: US 26D satin chrome, except rod shall be US 32D satin.
7. ANSI/BHMA: A156.8, C58511.
8. Products and Manufacturers: Provide one of the following:
 - a. GJ79H Extra Heavy-Duty Surface-Mounted Overhead Door Holders with J Mounting (as required) by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
 - b. Or equal.

H. Flush Bolts:

1. Provide flush bolts on the inactive leaf of all pairs of doors, unless otherwise specified.
2. Provide flush bolts at the top and bottom of door.
3. Provide the following features and materials:
 - a. Flush Bolt Levers: Forged Brass.
 - b. Flush Bolt Plate: Forge Brass.
 - c. Flush Bolt Guide and Strike: Wrought Brass.
 - d. Flush Bolt Rods: 1/2-inch round rods, bronze, 12-inches minimum length.
 - e. Bolt Head: Brass.
4. Provide extension flush bolts with 3/4-inch throws and with top bolt not over 6 foot-0 inches above finished floor. Provide bottom flush bolt 12-inches long.
5. ANSI/BHMA: A156.16: L14081, L14251 and L14091.
6. Products and Manufacturers: Provide one of the following:
 - a. GJ FB6 Extension Flush Bolts by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
 - b. Or equal.

- I. Astragals:
1. Provide metal astragal bar, not less than 1/8-inch by 2-inches, for exposed flathead screw mounting on active leaf of all pairs of doors. Comply with UL and NFPA requirements for types and locations of astragals.
 2. Provide astragal of cold-rolled steel with prime painted finish.
 3. Products and Manufacturers: Provide one of the following:
 - a. No. 357 Series by Pemko Manufacturing Company.
 - b. Or equal.
- J. Dust-Proof Strikes:
1. Provide brass dust-proof strikes, which incorporate a slotted plunger raised to flush position by spring tension for all flush bolts.
 2. Provide 5/8-inch inside diameter dust-proof strikes; threshold mounted and surface mounted.
 3. Finish: US 26D satin chrome.
 4. ANSI/BHMA: A156.16, L14011-L14012.
 5. Products and Manufacturers: Provide one of the following:
 - a. DP-1 and DP-2 by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
 - b. Or equal.
- K. Stripping and Seals:
1. Provide perimeter weather stripping at all exterior doors. Provide stripping and seals for interior doors where scheduled in List of Door Hardware Items at end of Part 3.
 2. Continuity of Stripping: Except as otherwise specified, stripping at each opening shall be continuous and without unnecessary interruptions at door corners and hardware.
 3. Replaceable Seal Strips: Resilient or flexible seal strip of every unit shall be easily replaceable and readily available from stocks maintained by the manufacturer.
 4. Provide bumper-type weather-stripping at jambs and head, including a resilient insert and metal retainer strip, surface-applied, of the following metal, finish and resilient bumper material:
 - a. Housing: Extruded aluminum with dark bronze anodized finish; 0.062-inch minimum thickness of main walls and flanges.
 - b. Dimensions: 1-3/8-inches by 7/8-inches, stop-mounted.
 - c. Seals: Closed-cell extruded silicone.
 - d. ANSI/BHMA: A156.22, R3E264.
 - e. Products and Manufacturers: Provide one of the following:
 - 1) No. 350DSPK and 2891 DPK (for parallel arms) by Pemko Manufacturing Company.
 - 2) Or equal.
 5. Provide heavy-duty automatic drop-seal sound-stripping door-bottom unit of manufacturer's standard design, with operating seal bar of the following material, retained in an extruded metal bar and capable of operating to close a

3/4-inch gap (from door bottom to floor or threshold). House mechanism and operating bar in the following metal housing, for mounting in doors as follows:

- a. Housing: Extruded aluminum, 0.062-inch thick, with mill aluminum finish.
- b. Seal: Closed-cell extruded silicone.
- c. Mounting: Full-mortise.
- d. ANSI/BHMA: A156.22, R3E344.
- e. Products and Manufacturers: Provide one of the following:
 - 1) No. 434APKL by Pemko Manufacturing Company.
 - 2) Or equal.

L. Thresholds:

1. All exterior and interior doors shall be provided with thresholds.
2. Metal: Mill finish aluminum.
3. Surface Pattern: Fluted tread, manufacturer's standard.
4. Provide countersunk stainless steel screws and expansion shields.
5. Width: Five-inches wide and of length sufficient to span full width of rough openings, coped and scribed neatly at and around door frames.
6. Construction:
 - a. Single-piece, complying with manufacturer's recommendations.
7. Profile: Provide manufacturer's unit, which conforms to the minimum size and profile requirements specified.
 - a. Floor Drop: Except where no change in floor elevation is shown from one side of threshold to the other, provide profile that accommodates 1/2-inch drop in floor elevation, unless another dimension is shown.
 - b. For doors equipped with panic hardware, including floor bolts, provide profile with stop bar of proper size and shape to function as the strike plate for the floor bolts.
8. Thickness: 1/2-inch, minimum.
9. ANSI/BHMA: A156.21, J12100.
10. Products and Manufacturers: Provide one of the following:
 - a. 171A by Pemko Manufacturing Company.
 - b. Or equal.

M. Silencers:

1. Provide silencers for all door frames.
2. Provide pneumatic design that, once installed, forms an air pocket to reduce noise.
3. Provide minimum of three per strike side of door jambs.
4. ANSI/BHMA: A156.16, BHMA 6.5, L03011.
5. Products and Manufacturers: Provide one of the following:
 - a. GJ 64 by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
 - b. Or equal.

N. Wall and Floor Stops: Provide the following where scheduled in List of Door Hardware Items at end of Part 3:

1. Dome-Type Floor Stops:

- a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
 - b. Coordinate height of dome-type floor mounted doors stops with threshold condition and undercut of door.
 - c. Finish: US 26D satin chrome.
 - d. ANSI/BHMA: A156.16, L12161.
 - e. Products and Manufacturers: Provide one of the following:
 - 1) FB13/14R, FB17 by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
 - 2) Or equal.
2. Wall Stops:
- a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
 - b. Convex rubber bumper.
 - c. ANSI/BHMA: A156.16, L12101.
 - d. Products and Manufacturers: Provide one of the following:
 - 1) GJ 50C by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
 - 2) Or equal.
- O. Sealants: Provide elastomeric sealant complying with FS TT-S-00227, Type 2 (non-sag) Class A for use with thresholds.

2.3 HARDWARE FINISHES

- A. Provide matching finishes for door hardware units at each door or opening, to the greatest extent possible in compliance with ANSI/BHMA A156.18.
- B. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of door hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish for the latch and lock set for color and texture.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the substrate to receive door hardware, and the conditions under which the Work will be performed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the door hardware Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

- A. Templates: Furnish door hardware templates to each fabricator of doors, frames and other Work to be factory-prepared for the installation of door hardware. Check the

Shop Drawings of such other Work, to confirm that adequate provisions are made for the proper installation of the door hardware.

- B. Prepare Work to receive door hardware Work in compliance with ANSI/DHI A115.1.

3.3 INSTALLATION

- A. Installer shall check and approve the installation before operation. Installer shall assure that the system operates to the OWNER'S satisfaction.
- B. Mount door hardware units at heights recommended in, Door and Hardware Institute, "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames" and "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames", except as otherwise specified or required to comply with governing authorities having jurisdiction at the Site, HMMA 830 and ADAAG requirements.
- C. Install each door hardware item in compliance with the manufacturer's instructions and recommendations and approved Shop Drawings. Wherever cutting and fitting is required to install door hardware onto or into surfaces that are later to be painted or finished in another way, install each item completely, then remove, and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- F. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.
- G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel that will not corrode in contact with the threshold metal.
- H. Set thresholds in a bead of elastomeric sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant before sealant cures to a firm set.
- I. Adjust and check each operating item of door hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with the type lubrication recommended by manufacturer (graphite-type if no other recommended).

Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

- J. Final Adjustment: Where door hardware installation is made more than one month prior to Substantial Completion, return to the Work during the week prior to acceptance or occupancy, and make a final check and adjustment of all door hardware items in each space and area. Clean and re-lubricate operating items as necessary to restore proper function and finish of door hardware and doors. Adjust door control devices to compensate for final operating of heating and ventilating equipment.
- K. Provide manufacturer's authorized representative to instruct and train OWNER'S personnel in proper adjustment and maintenance of door hardware during the final adjustment of door hardware.
- L. Door hardware, which is blemished or defective, will be rejected even though it was set in place before defects were discovered. Remove and replace with new door hardware. Repair all resultant damage to other Work.
- M. Continued Maintenance Service: Approximately six months after the acceptance of door hardware in each area, the installer, accompanied by the representative of the latch and lock manufacturer, shall return to the Project and re-adjust every item of hardware to restore proper function of doors and door hardware. Consult with and instruct OWNER'S personnel in recommended additions to the maintenance procedures. Clean and lubricate operational items wherever required. Replace door hardware items that have deteriorated or failed due to faulty design, materials or installation of door hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the door hardware.

3.4 FIELD QUALITY CONTROL

- A. Provide a written field report, prepared by installer's architectural hardware consultant, identifying actual condition, location, manufacturer, and product designation for each item of door hardware actually present on each door at the Site, including whether door hardware is adjusted and operating properly, compared with each item referenced to approved Shop Drawings and Contract requirements.
- B. Installer's hardware consultant shall provide opinions to, and assist ENGINEER in determining, acceptability of installation as Work proceeds. All comments and discussions, conversations and meetings with ENGINEER shall be included in written field report for submission to ENGINEER for review and approval at completion of door hardware installation.
- C. As part of written field report to be submitted to ENGINEER for approval, recommend remedial actions for Work not in compliance with these Specifications. No payment for Work shall be made until remedial recommendations and actions have been approved by ENGINEER and incorporated into the Work.

3.5 LIST OF DOOR HARDWARE ITEMS

- A. Scheduled items for each door are generic and rely on information specified above. The listing of hardware functions and types provided are only a general guideline for the final Door Hardware Schedule. CONTRACTOR shall submit a Door Hardware Schedule acceptable to all governing authorities having jurisdiction at the Site.
- B. Provide the following door hardware items:

Hardware Sets (Coordinate with Door Schedule for locations)

1. Exterior Single Egress Doors and Frames
 - a. Mortise hinges.
 - b. High-security mortise panic exit devices.
 - c. Overhead, surface-mounted, door closers.
 - d. Stripping and seals.
 - e. Thresholds.
 - f. Silencers.
 - g. Overhead holders and stops.
2. Exterior Pair Egress Doors and Frames
 - a. Mortise hinges.
 - b. High-security mortise panic exit devices.
 - c. Overhead, surface-mounted, door closers on both doors.
 - d. Overhead holders and stop.
 - e. Flush bolts.
 - f. Astragals.
 - g. Stripping and seals.
 - h. Thresholds.
 - i. Silencers.
 - j. Dust-proof strikes
3. Interior Single Egress Doors and frames
 - a. Mortise hinges.
 - b. High-security mortise panic exit devices.
 - c. Overhead, surface-mounted, door closers.
 - d. Stripping and seals.
 - e. Thresholds.
 - f. Silencers.
 - g. Floor or wall stops.
4. Interior Single Door and Frame – Privacy and Toilet
 - a. Mortise hinges.
 - b. High-security mortise locksets and latchsets.
 - c. Overhead, surface-mounted, door closers.
 - d. Thresholds. Exclude closer on Door 107-1.
 - e. Silencers.
 - f. Floor or wall stops.
5. Interior Single Door and Frame - Passage
 - a. Mortise hinges.

- b. High-security mortise locksets and latchsets.
- c. Overhead, surface-mounted, door closers.
- d. Thresholds.
- e. Silencers.
- f. Floor or wall stops.

+ + END OF SECTION + +

SECTION 08 81 00

GLASS GLAZING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install glass glazing.
2. Extent of glass glazing is shown.
3. Types of products required include the following.
 - a. Clear, float glass.
 - b. Tinted, float glass.
 - c. Clear, wired, float glass.
 - d. Clear, heat-strengthened, float glass.
 - e. Clear, fully tempered, float glass.
 - f. Clear, laminated, float glass.
 - g. Clear, pyrolytic-coated, float glass.
 - h. Clear, insulating, float glass.
 - i. Clear, wavelength-selective, insulating, float glass.
 - j. Ceramic-coated, clear, float glass.
 - k. Ceramic-coated, opaque, float glass.
 - l. Structural and non-structural glazing sealants.
 - m. Miscellaneous glazing, spacers, tapes and other materials.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the glass glazing Work.

C. Related Sections:

1. Section 07 92 00, Joint Sealants.
2. Section 08 51 13, Aluminum Windows.
3. Section 10 28 05, Toilet and Bath Accessories.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Architectural Manufacturers Association, (AAMA).
 - a. AAMA 800, Voluntary Specifications and Test Methods for Sealants.
2. American National Standards Institute, (ANSI).
 - a. ANSI Z97.1, Safety Glazing Materials Used in Buildings.
 - b. ANSI/ASTM E 774, Specification for Classification of the Durability of Sealed Insulating Glass Units.

- c. ANSI/ASTM E 1300, Practice for Determining Load Resistance of Glass in Buildings.
- 3. American Society of Civil Engineers, (ASCE).
 - a. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
- 4. American Society for Testing and Materials, (ASTM).
 - a. ASTM C 509, Specification for Elastomeric Cellular Performance Gasket and Sealing Material.
 - b. ASTM C 719, Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement (Hockman Cycle).
 - c. ASTM C 793, Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants.
 - d. ASTM C 794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
 - e. ASTM C 864, Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
 - f. ASTM C 920, Specification for Elastomeric Joint Sealants.
 - g. ASTM C 1021, Practice for Laboratories Engaged in Testing of Building Sealants.
 - h. ASTM C 1036, Specification for Flat Glass.
 - i. ASTM C 1048, Specification for Heat-Treated Flat Glass-Kinds HS, Kind FT Coated and Uncoated Glass.
 - j. ASTM C 1087, Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
 - k. ASTM C 1115, Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
 - l. ASTM C 1172, Specification for Laminated Architectural Flat Glass.
 - m. ASTM C 1249, Guide for Secondary Seal for Sealed Insulating Glass Units for Structural Sealant Glazed Applications.
 - n. ASTM C 1281, Specification for Preformed Tape Sealants for Glazing Applications.
 - o. ASTM C 1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
 - p. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - q. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - r. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.
 - s. ASTM E 548, Guide for General Criteria Use for Evaluating Laboratory Competence.
- 5. Code of Federal Regulations, (CRF).
 - a. 16 CFR, Consumer Product Safety Commission, CPSC Part 1201, Safety Standard for Architectural Glazing Materials.
- 6. Glass Association of North America, (GANA).
 - a. GANA, Glazing Manual.
 - b. GANA, Laminated Glass Design Guide.
 - c. GANA, Glass Tempering Division, GTA 95-1-31, Specification for Decorative Architectural Flat Glass.

7. Lawrence Berkeley National Laboratory National Technical Information Service, (LBL).
 - a. LBL-35298 Window 4.1, "A PC Program for Analyzing the Thermal Performance of Fenestration Products."
8. National Fire Protection Association, (NFPA).
 - a. NFPA 80, Standard for Fire Doors and Fire Windows.
 - b. NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
 - c. NFPA 257, Standard on Fire Tests for Window and Glass Block Assemblies.
9. National Fenestration Rating Council, (NFRC).
 - a. NFRC 100, Procedure for Determining Fenestration Product U-Factors.
 - b. NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - c. NFRC 300, Procedures for Determining Solar Optical Properties of Simple Fenestration Products.
10. National Glass Association, (NGA).
 - a. NGA, Glazier Certification Program.
11. Primary Glass Manufacturers Council, (PGMC).
 - a. PGMC Specifiers' Guide to Architectural Glass.
12. Sealed Insulating Glass Manufacturers Association, (SIGMA).
 - a. SIGMA TM-3000-90, Vertical Glazing Guidelines and TB-3001-90, Sloped Glazing Guidelines.
13. Underwriters' Laboratories, Inc., (UL).
 - a. UL Building Materials Directory.

1.3 QUALITY ASSURANCE

- A. Primary Glass Manufacturer and Glazing Materials Manufacturer Qualifications:
 1. Provide glass glazing materials manufactured by firms specializing in the production of the types of glass glazing products specified, in compliance with specified standards.
 2. Provide glass from manufacturers who are members of GANA and PGMC and participate in certification programs.
 3. Obtain glass glazing materials from manufacturers who will send a qualified technical representative to the Site, for the purpose of advising the installer of proper procedures and precautions for the use of the materials and who will assist ENGINEER with opinions on the acceptability of materials and Work.
- B. Fabricator Qualifications:
 1. Provide laminated and insulating glass fabrications from fabricators who are licensed by primary glass manufacturer to produce specified units and with documented skill and successful experience in this type of Work and who agree to employ only tradesmen who are trained, skilled and have successful experience in this type of Work.
 2. Provide laminated and insulating glass fabrications from fabricators who are members of GANA or SIGMA and participate in certification programs.

3. Obtain laminated and insulating glass fabrications from fabricators who will, if required, send a qualified technical representative to the Site, for the purpose of assisting ENGINEER with opinions on the acceptability of materials and installation methods.
- C. Installer's Qualifications:
1. The installer of the glass glazing materials shall be a firm with documented skill and successful experience in the installation of the types of materials required and who agrees to employ only tradesmen who are trained, skilled and have successful experience in the types of materials and glazing systems specified and who are certified under the National Glass Association Glazier Certification Program as Level 3 (Master Glaziers).
 2. Submit records of experience and certifications to ENGINEER.
- D. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing specified, as documented according to ASTM E 548.
- E. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct testing specified, as documented according to ASTM E 548.
- F. Source Limitation: All materials provided under this Section shall be obtained from a single supplier or manufacturer who, with CONTRACTOR, shall assume full responsibility for the completeness of the Work. The supplier or manufacturer shall be the source of information on all material furnished regardless of the manufacturing source of that material.
- G. Regulatory Requirements:
1. Wherever a fire-resistance-rating classification is shown or scheduled for doors or windows, (1-hour, 2-hour, 3-hour), provide glass complying with the requirements specified and established by UL, NFPA and other governing authorities having jurisdiction at the Site.
 2. Safety Glass: Comply with ANSI Z97.1, with label on each piece of glass as required by governing authorities having jurisdiction.
- H. Codes: Comply with applicable requirements of codes referenced in Section 01 42 00, References.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Plans and elevations showing location of each type and kind of glass specified and details of glazing system. Include manufacturer's recommendations for glazing.

- b. Dimensions and details of manufacturer's glue line thickness and bite dimensions and verifications.
 - 2. Product Data:
 - a. Copies of manufacturers' specifications, "Spec-Data" sheets, installation instructions for each type of glass, glazing sealant or compound, gasket and associated miscellaneous material and all recommended installation precautions for required materials and components, which are not included in other submittals, specified in other Sections. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.
 - b. Structural performance calculations indicating that detailing and fabrication have been based on the results of the required analysis and performance criteria specified.
 - 3. Delegated design Submittals:
 - a. Structural silicone sealant performance features and calculations indicating sealant joints have been detailed and fabricated in compliance with silicone sealant manufacturer's recommended guidelines for dissimilar metal adhesion. Structural and other performance calculations for the structural silicone joints shall be prepared, signed and stamped with the seal of a Registered Professional Engineer, licensed to practice in the State of Connecticut, and recognized as an expert in the required Work.
 - 4. Samples:
 - a. 12-inch square samples of each type of glass required.
 - b. Insulating glass samples need not be hermetically sealed, but edge construction, wavelength-selective interlayer and low-E coatings shall be included and identified. Include specially prepared samples with each interlayer film product's identity marked on film and incorporated into sample.
 - c. Submit 12-inch long samples of each color for each type of exposed-to-view glazing sealant and gasket. Install sample between two strips of material similar to, or representative of, channel surfaces where sealant or gasket will be used, held apart to represent typical joint widths.
 - d. Review of samples by ENGINEER will be for color, texture and pattern only. Compliance with other requirements is the responsibility of CONTRACTOR.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Wavelength-selective or low-E glass fabricator shall provide a letter of compliance verifying performance characteristics of each glass unit.
 - b. Certification that all glass materials subject to the applicable standards of the CPSC are in compliance. The certification shall be issued in conformance with procedures stated in the standard.
 - c. Include primary glass manufacturer's and fabricator's published data, and letters of certification, based on certified test laboratory reports,

indicating that each material complies with specified requirements and is acceptable for the applications shown.

- d. Certification that fabricated products comply with manufacturer's published performance.
- e. Age of silicone sealant.
- 2. Test Reports:
 - a. Certified laboratory test reports for required performance tests in compliance with ASTM E 548.
 - b. Adhesion and compatibility test report from glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glazing channel substrates and for compatibility with glass and other glazing material.
 - c. Performance analysis of each configuration of insulating glass incorporating wavelength selective interlayer or low E coating using LBL-35-298, Window 4.1.
- 3. Qualifications Statements:
 - a. Fabricator.
 - b. Installer.

C. Closeout Submittals: Submit the following:

- 1. Warranty Documentation:
 - a. Manufacturer's and fabricator's guarantees, as specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

- 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:

- 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- 2. Protect glass glazing materials according to manufacturer's and fabricator's written instructions to prevent damage to glass glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- 3. For insulating glass that will be exposed to substantial altitude changes, comply with insulating glass fabricator's written recommendations for venting and sealing to avoid hermetic seal ruptures.

C. Acceptance at Site:

- 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.6 SPECIAL WARRANTIES

- A. General: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.
- B. Special Warranties:
1. Laminated Glass: Provide written warranty, signed by the fabricator and CONTRACTOR and running to benefit of OWNER, agreeing to replace, for a period of five-years from the date of Substantial Completion, glass units that show deterioration, as specified.
 2. Insulating Glass: Provide written warranty, signed by the fabricator and CONTRACTOR and running to the benefit of OWNER, agreeing to replace, for a period of ten-years from the date of Substantial Completion, glass that shows signs of deterioration, as specified.
 3. Structural Silicone: Provide structural silicone manufacturer's twenty-year limited adhesion warranty and non-staining warranty for silicone structural adhesive, commencing from the date of Substantial Completion. Perform all testing required to achieve the warranties.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Design Criteria: For glass performance, manufacture, size, type, construction and thickness, comply with the following:
1. Provide glass glazing systems capable of withstanding normal thermal movements and wind and impact loads without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants (both structural and weather-resisting) to remain watertight, airtight and to maintain structural performance characteristics specified; deterioration of glazing materials; or other defects in construction.
 2. Normal Thermal Movement: Provide glass that allows for thermal movements resulting from a maximum temperature range of 120°F in ambient and 180°F surface temperature acting on glass framing members and glazing components. Base structural performance calculations on surface temperatures of materials caused by both solar heat gain and nighttime-sky loss.
 3. Comply with requirements of Consumer Product Safety Commission, Part 1201, Safety Standards for Architectural Glazing Materials, for all the Work.
 4. Structural Performance: Provide structural calculations for analysis of required glass thicknesses for glass lites shown, that are used to establish final fabricating and detailing requirements. Indicate compliance with the following minimum criteria for all glass shown:
 - a. Project Wind Speed: 70 miles per hour based on ASCE 7 and the other governing authorities having jurisdiction at the Site.

- b. Importance Factor: Category 1; $I_w = 1.15$; Design Factor: 1.15.
 - c. Exposure Category: Exposure C; $C_e = 1.13$.
 - d. Wind Stagnation Pressure: $q_s = 12.6$ psf.
 - e. Long-Duration Loading: One month.
 - f. Short-Duration Loading: Sixty seconds, based on three-second gust speed.
 - g. Probability of Breakage for Vertical Glazing: Eight lites per 1,000 under wind action.
 - h. Maximum Lateral Deflection: For glass supported on all four edges, provide thickness required to limit center deflection at design wind pressure to 1/50 times the short side length or 1-inch, whichever is less.
5. Glass thicknesses shown are minimums. Confirm glass thicknesses by analyzing Project structural loadings and in-service conditions using glass manufacturer's recommended load tables and other structural performance criteria specified. Where manufacturer's load tables indicate acceptability of lesser thickness material than required by performance criteria specified, provide specified thicknesses and features as a minimum. Where load tables indicate the need for greater thickness, or additional features, than specified, provide greater thicknesses and features at no additional cost to OWNER. Comply with practice for determining minimum thickness and types of glass, to resist loadings required by governing authorities having jurisdiction at the Site, according to ANSI/ASTM E 1300.
 6. Test sealant in accordance with sealant manufacturer's recommendations.
 7. Provide each configuration of insulating glass incorporating wavelength-selective interlayers or low-E coatings.
 8. Glazing Sealant System Compatibility:
 - a. Glazing sealants shall be compatible with the channel surfaces, joint fillers, insulating glass sealing system, laminated glass interlayer material and other materials in contact with the glazing channel in compliance with ASTM C 1087.
 - b. Provide only materials and manufacturer's recommended variation of the specified materials, which are known to be fully compatible with the actual installation conditions, as shown by manufacturer's published data or certification submitted to ENGINEER for approval.
 9. Adhesion of Elastomeric Joint Sealants: Comply with ASTM C 793 and ASTM C 794.
 10. Center-of-Glass U-Values: NFRC 100 methodology using LBL-35298 WINDOW 4.1 computer-aided software design, expressed as Btu/square foot by height by degree F.
 11. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer-aided software design.
 12. Solar Optical Properties: NFRC 300.

B. Definitions:

1. Interspace: The space between lites of an insulating glass unit that contains dehydrated air or a specified gas.

2. Deterioration of Coated Glass: Defects that develop from normal use, that are attributed to the manufacturing process, and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
3. Deterioration of Laminated Glass: Defects that develop from normal use, that are attributed to the manufacturing process, and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass or structural performance or safety of units; blemishes exceeding those allowed by specified laminated glass standards; and cracking, crazing or color change of films concealed in the lamination.
4. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use that is attributed to the fabricating process or incompatibility of sealants or mishandling during installation, and not to causes other than glass breakage and practices for maintaining and cleaning glass contrary to manufacturer's written instructions. Evidence of failure shall include the obstruction of vision by dust, moisture, or film on interior surfaces of insulating glass.

2.2 GLASS

A. Clear, Float Glass:

1. Uncoated, Monolithic, Clear, Float Glass: Provide clear glass in compliance with ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality q³ (glazing select); 1/4-inch thick, minimum.
2. Products and Manufacturers: Provide one of the following:
 - a. Clear Float Glass by PPG Industries, Incorporated.
 - b. Clear Float Glass by Pilkington Libbey-Owens-Ford Company.
 - c. Or equal.

B. Clear, Wired, Float Glass:

1. Uncoated, Monolithic, Clear, Wired, Float Glass: Provide rolled glass having a layer of meshed wire completely embedded in the sheet in compliance with ASTM C 1036, Type II (patterned and wired glass, flat), Class 1 (clear), Form 1 (wired, polished both sides), Quality q⁸ (glazing select), Mesh m² (square); 1/4-inch thick, minimum.
 - a. Provide orthogonally oriented wire versus diamond-patterned.
2. Products and Manufacturers: Provide one of the following:
 - a. Clear Wired Float Glass by AFGD, Incorporated.
 - b. Clear Wired Float Glass by Pilkington Libbey-Owens-Ford Company.
 - c. Or equal.
3. All windows shall be provided with clear, wired, float glass on exterior pane of insulated glass unit.

C. Clear, Laminated, Float Glass:

1. Uncoated, Monolithic, Clear, Float Glass: Provide clear glass laminated in compliance with ASTM C 1172.
 2. Kind: LA - Two or more lites of flat annealed transparent glass conforming to the applicable requirements of ASTM C 1036 and bonded by an interlayer material and as follows:
 - a. Outer Lite: Type I (transparent glass, flat), Class 1 (clear), Quality q³ (glazing select); 1/4-inch thick, minimum.
 - b. Inner Lite: Type I (transparent glass, flat), Class 1 (clear), Quality q³ (glazing select), 1/4-inch thick, minimum.
 3. Plastic Interlayer Material: 0.060-inch polyvinyl butyral sheets or cured resin.
 4. Products and Manufacturers: Provide one of the following:
 - a. Laminated Glass by Bentemp North American Glass an Affiliate of HGP Industries, Incorporated.
 - b. Securpane Laminated Glass by Interpane Glass Company.
 - c. Or equal.
- D. Clear, Insulating, Float Glass Units:
1. Uncoated, Monolithic, Clear, Float Glass: Provide clear glass in compliance with ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality q³ (glazing select).
 2. Insulating Glass Units: Provide preassembled units consisting of two lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class C units, permanently and hermetically sealed together at edges with spacers and sealant.
 3. System Sealing: Dual seal with polyisobutylene primary sealant and silicone secondary sealant, complying with ASTM C 1249.
 4. Overall Unit Thickness and Thickness of Each Lite:
 - a. Overall Thickness: 1-inch.
 - b. Each Lite: 1/4-inch.
 5. Physical Properties:
 - a. Exterior Appearance: Clear.
 - b. Visible Light Transmittance: 78 percent, minimum.
 - c. Solar Heat Gain Coefficient: 0.70.
 - d. Outdoor Visible Light Reflectance: 15 percent.
 - e. Shading Coefficient: 0.81.
 - f. Winter Nighttime U-value: 0.48.
 - g. Summer Daytime U-value: 0.55.
 6. Products and Manufacturers: Provide one of the following:
 - a. Clear Twindow by PPG Industries, Incorporated.
 - b. Clear Thermopane by Pilkington Libbey-Owens-Ford Company.
 - c. Or equal.
- E. Ceramic-Coated, Clear, Float Glass:
1. Ceramic-Coated Vision Glass: Provide float glass with fired, decorative, ceramic enamel coating applied by silk-screening process on second surface and complying with ASTM C 1048, Type I (transparent glass, flat), Class 1 (clear), Quality q³ (glazing select), Condition C (other coated glass), Kind HS

- (heat-strengthened glass); complying with GTA 95-1-31; 1/4-inch thick, minimum.
2. Ceramic Coating Color and Pattern: Complete selection of manufacturer's standard and custom ceramic colors and patterns.
 3. Products and Manufacturers: Provide one of the following:
 - a. Dzigns Ceramic-Pattern Coated Glass by Interpane Glass Company.
 - b. Designlite Fired Ceramic Decorated Glass by Guardian Industries, Incorporated.
 - c. Or equal.

2.3 GLAZING SEALANTS, TAPES AND GASKETS

A. General:

1. Colors: Provide black or other natural color wherever no other color is available. Wherever material is not exposed-to-view, provide manufacturer's standard color, which has the best overall performance characteristics for the application shown.
 - a. Provide manufacturer's standard colors as shown or, if not shown, provide color selected by ENGINEER from manufacturer's standard colors to either blend or contrast with adjoining surfaces.
2. Hardness specified is intended to indicate the general range necessary for overall performance. Submit glazing and sealant manufacturer's recommendations for actual hardness for each condition of installation and use. Except as shown or specified, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75°F):
 - a. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 united inches). Provide material sufficiently hard to withstand exposure to abrasion and vandalism.
 - b. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 united inches). Provide materials sufficiently hard to withstand impact of moving sash and doors.
 - c. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for application or insertion of units.
 - d. 75 to 80 for structural gaskets (not supported by stops).
 - e. Non-Elastomeric Compounds: (Shore A not applicable) 2 to 12 mm penetration for 5.0 seconds of penetrometer needle on nominally cured compound, complying with ASTM D 2451.
3. Provide size and shape of gaskets and preformed glazing units as recommended by the manufacturer and as indicated on approved Shop Drawings.
4. Comply with ASTM C 920 and other requirements for each liquid-applied, chemically curing sealant specified.
5. Where additional movement capability is specified, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement, in compliance with ASTM C 719, to withstand the specified

percentage change in the joint width existing at the time of installation and remain in compliance with other requirements in ASTM C 920 for uses shown.

- B. Preformed Butyl Rubber Back-Bedding Mastic Glazing Tape:
 - 1. Preformed tape of polymerized butyl or mixture of butyl and polyisobutylene with inert fillers with built-in spacer of synthetic rubber, solvent-based with minimum 95 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, complying with AAMA 806.3.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Polyshim II Glazing Tape by Tremco, Incorporated.
 - b. Or equal.
- C. Dense Compression Wedge Gaskets:
 - 1. Provide molded or extruded, closed-cell silicone wedge gaskets in compliance with ASTM C 1115, Type C.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Dense Silicone Wedge Gaskets SCR-900 by Tremco, Incorporated.
 - b. Or equal.
- D. Exterior, One-Part, Silicone Rubber Sealant:
 - 1. Silicone rubber-based, one-part elastomeric sealant, complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, G, A and O.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Spectrem I by Tremco, Incorporated.
 - b. 863 Architectural Silicone Sealant by Pecora Corporation.
 - c. Or equal.
- E. Structural Silicone Sealant:
 - 1. Provide a one-component, self-priming, shelf-stable, neutral-cure, elastomeric adhesive complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, G and A, and specifically formulated for silicone structural glazing complying with the following as-cured physical properties, after seven days at 77°F and 50 percent relative humidity:
 - 2. Durometer Hardness, Shore A, points; ASTM D 2240: 27 to 40.
 - 3. Ultimate Tensile, ASTM D 412: 225 to 350 psi.
 - 4. Ultimate Elongation, ASTM D 412: 525 to 550 percent.
 - 5. Tear Strength, Die B; ASTM D 624: 40 to 49 ppi.
 - 6. Peel Strength, ASTM C 794: 30 to 40 ppi.
 - 7. Products and Manufacturers: Provide one of the following:
 - a. DOW CORNING 995 Silicone Structural Adhesive by Dow Corning Corporation.
 - b. 895 Silicone by Pecora Corporation.
 - c. Or equal.

2.4 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standards, requirements of manufacturers of glass glazing materials for applications shown, and approved Shop Drawings. Provide materials with a proven record of compatibility with surfaces shown and specified.
- B. Setting Blocks: Elastomeric material, 80 to 90 Shore A durometer hardness, with proven compatibility with sealants used in the Work and as recommended by the glass manufacturer.
- C. Spacers and Edge Blocks: Elastomeric blocks or continuous extrusions, with a Shore A durometer hardness recommended by glass manufacturer to maintain lites in place and to limit lateral movement for installation shown, and with proven compatibility with sealants used in the Work.
- D. Cylindrical Glazing Sealant Backing: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam complying with ASTM C 1330, Type O (open-cell material), proven to be compatible with sealants used, flexible and resilient, with 5 to 10 psi compression strength for 25 percent deflection.
- E. Cleaners, Primers and Sealers: Type recommended by sealant, gasket and glass manufacturer.

2.5 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Glass manufacturer's recommended glazing channel dimensions are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. CONTRACTOR shall be responsible for correct glass size for each opening, within the tolerances and necessary dimensions established on approved Shop Drawings.

2.6 SOURCE QUALITY CONTROL

- A. To the greatest extent possible, provide each type of glass glazing materials from one manufacturer.
- B. Providing insulating glass with a certified Class A rating according to SIGMA.
- C. Obtain glass and sealant test results for product test reports from qualified testing agencies regularly engaged in the business of testing glass and sealant products.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glass glazing is to be performed, and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

- A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings, which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.
- B. Apply primer or sealer to joint surfaces wherever recommended by sealant and glass manufacturer.

3.3 INSTALLATION

- A. General:
 - 1. Comply with combined recommendations of glass, window and glazing products manufacturers and other materials used in glazing, except where more stringent requirements are shown or specified, and as shown on approved Shop Drawings.
 - 2. Comply with GANA, Glazing Manual, except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass glazing materials, as accepted by ENGINEER on approved Shop Drawings.
 - 3. Inspect each piece of glass immediately before installation, and remove from Site all that have observable edge damage or face imperfections.
 - 4. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.
 - 5. Cut and install tinted and reflective glass as recommended in manufacturer's technical bulletin as provided on approved Shop Drawings.
 - 6. Install sealants as recommended by sealant manufacturers, and as recommended on approved Shop Drawings.
 - 7. Do not attempt to cut, seam, nip or abrade glass on Site, which is tempered, heat strengthened, or coated.
 - 8. Do not proceed with installation of liquid glazing sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
 - 9. Proceed with glazing only when forecasted weather conditions are favorable to proper cure and development of high early bond strength. Wherever channel action is affected by ambient temperature variations, install glazing sealants only when temperatures are in the middle third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation or compression, and bond stress will not be excessive at extremely low or high temperatures.

10. Coordinate the installation of the glass glazing Work with the Progress Schedule in order to avoid delay of Project.

B. Tape and Sealant Glazing:

1. Place setting blocks in sill rabbets, sized and located to comply with referenced glazing publications. Set blocks in thin course of compatible sealant for heel bead. Position glass on setting blocks and press against tape for full contact.
2. Provide spacers for glass lites where the length plus width is larger than 4 foot-2 inches. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
3. Provide 1/8-inch minimum bite for spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
4. Provide edge spacers as shown on approved Shop Drawings and as required to prevent glass lites from moving sideways in glazing channel.
5. Cut glazing tape to length and set against permanent stops. Install horizontal strips first, extending over width of opening, before applying vertical strips.
6. Remove paper backing from tape. Place glazing tape on free perimeter of glass. Install tapes continuously. Do not stretch tape to make them fit openings. Place joints in tapes at corners of openings with adjoining lengths butted together, not lapped. Seal butt joints of tape with joint sealant.
7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
8. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Calk space above glazing tape to top of glazing stop. Tool exposed surfaces of sealant compounds to provide a substantial "wash" away from the glass.
9. Clean and trim excess glazing materials from the installation, and eliminate stains and discolorations.
10. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended on approved Shop Drawings and to prevent corners from pulling away; seal corner joints and butt joints with sealant as recommended by gasket manufacturer and as shown on approved Shop Drawings.

- C. Dry Gasket Glazing: Install glass in gaskets as recommended by the glass and window manufacturer. Refer to Section 08 11 13, Hollow Metal Doors and Frames and Section 08 51 13, Aluminum Windows.
- D. Structural Sealant Glazing: Install glass using a system of structural silicone sealants as recommended by the glass and sealant manufacturers.
- E. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.
- F. The installer shall advise CONTRACTOR of procedures required for the protection of glass glazing sealants and compounds during the construction period, so that they will be without deterioration or damage, other than normal weathering, at the time of Substantial Completion.
- G. Furnish specific instructions on the precautions and provisions required to prevent glass damage resulting from the alkaline wash from concrete surfaces and similar sources of possible damage.
- H. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.
- I. Remove and replace glass, which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.
- J. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other work.
- K. Remove non-permanent labels and wash and polish glass on both faces not more than four days prior to Substantial Completion. Comply with glass manufacturer's recommendations for cleaning.

3.4 FIELD QUALITY CONTROL

- A. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the Work.
- B. After nominal cure of exterior glazing sealants, which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch

hose held perpendicular to wall face, 2 foot-0 inches from joint, connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 foot-0 inches per minute.

- C. Test approximately five percent of total glazing system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct tests in the presence of ENGINEER, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.
- D. Repair glazing installation at leaks or, if leakage is excessive, replace glazing sealants as directed by ENGINEER.
- E. Wherever nature of observed leakage indicates the possibility of inadequate glazing joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme temperatures, and returned to the range of temperature in which it is feasible to conduct testing. Repair or replace Work as required and directed by the ENGINEER.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE++

SECTION 08 90 00

LOUVERS AND VENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all louvers and vents Work.
2. Extent of louvers and vents Work is shown.
3. Types of products required include the following:
 - a. Six-inch fixed, extruded-aluminum louvers.
 - b. Sill extensions, bird screens, insect screens, and other miscellaneous trim, fasteners, blank-off panels, supports and other accessories.
 - c. Anodic finish.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the louvers and vents Work.
2. Verify size, location and placement of louver and vents prior to fabrication, wherever possible. Coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in as large sections as practicable.
3. Coordinate louver selections with Section 23 09 00, Instrumentation and Control for HVAC.

C. Related Sections:

1. Section 07 92 00, Joint Sealants.
2. Section 23 09 00, Instrumentation and Control for HVAC (for actuators for operable louvers).

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Society for Testing and Materials, (ASTM).
 - a. ASTM B 117, Practice for Operating Salt Spray Apparatus.
 - b. ASTM D 522, Test Methods for Mandrel Bond Test of Attached Organic Coatings.
 - c. ASTM D 523, Test Method for Specular Gloss.
 - d. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - e. ASTM D 2244, Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

- f. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
- g. ASTM D 3363, Test Method for Film Hardness by Pencil Test.
- h. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.

1.3 QUALITY ASSURANCE

- A. Performance Criteria: Comply with Sheet Metal and Air Conditioning Contractor's National Association, Architectural Sheet Metal Manual, recommendations for fabrication, construction details, and installation procedures, except as otherwise shown on the Drawings or specified.
- B. Component Supply and Compatibility:
 - 1. Obtain each separate type of louver and vents from a single supplier and from a single manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following
 - 1. Shop Drawings:
 - a. Include plans, elevations, sections, details and attachments to other work. Show blade profiles, angles and spacing.
 - 2. Product Data:
 - a. Copies of manufacturer's material specifications, recommended written installation instructions and manufacturer's specifications showing
 - 3. Delegated Design Submittals:
 - a. For installed louvers and vents indicated to comply with design loads, include structural analysis data signed and sealed by a Registered Professional Engineer licensed in the State of Connecticut, who is responsible for their preparation.
 - 4. Samples: For units with factory-applied color finishes.
 - a. Cut-a-way samples of corner section of each type of louver made from 12-inch lengths of full size components and showing the proposed details of joinery, anchorage, movement, glazing, flashing and drainage and with specified finish, prior to fabrication of the Work.
 - 1).ENGINEER reserves the right to require samples demonstrating design, detailing and fabrication techniques and workmanship for each auxiliary louver component and accessory, before fabrication proceeds.
 - b. Provide anodized finish manufacturer's complete color charts.
 - c. One of each type fastener employed, with statement of intended use.
 - d. Samples will be reviewed by ENGINEER for materials, fabrication techniques, proposed system components, workmanship and color. Compliance with other requirements is the responsibility of CONTRACTOR.

- C. Informational Submittals: Submit the following:
 - 1. Source Quality Control Submittals:
 - a. Comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 WARRANTY

- A. Provide written warranty agreeing to replace louver and vent Work which fails in materials or workmanship within three years of the date of Final Acceptance. Failure of materials or workmanship shall include, but is not limited to, excessive leakage or air infiltration, excessive deflections, deterioration of finish or metal in excess of normal weathering, and defects in accessories, weatherstripping, and other components of the Work.

PART 2 - PRODUCTS

2.1 LOUVER AND VENTS PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
 - 1. Wind Loads: Determine loads based on a uniform pressure of 35 lbf/sq.ft., acting inward or outward.
- B. Seismic Performance: Provide louvers capable of withstanding the effects of earthquake motions determined according to the International Building Code and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads".
 - 1. Seismic Design Criteria:
 - a. Soil Classification (Site Class): D
 - b. Spectral Response Acceleration Coefficient: $S_s=20.6\%$, $S_1=6.5\%$
- C. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 20°F, ambient; 120°F, material surfaces.

2.2 MATERIALS

- A. Aluminum Sheet: ASTM B 209, Alloy 5005 with temper as required for forming or as otherwise recommended by the metal producer to provide the required finish.
- B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T52.
- C. Fastenings: Use same material as items fabricated. Provide types, gages and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise specified. Use continuous aluminum closure angles on the inside perimeter frame of all louver and vents Work, finished to match louvers and vents.
- D. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to four times the loads imposed, for concrete, or six times the loads imposed, for masonry, as determined by testing conforming to ASTM E 488, conducted by a qualified independent testing agency.
- E. Protection of aluminum from dissimilar materials shall conform to Section 09 91 00, Painting.

2.3 FABRICATION, GENERAL

- A. Assemble louvers and vents in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver and vent units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern, unless horizontal mullions are shown.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes as shown, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 1. Frame Type: Channel, unless otherwise shown and as specified.
- E. Include supports, anchorages, and accessories required for complete assembly.

- F. Provide vertical mullions of type and at spacing shown, but not more than recommended by manufacturer, or 72-inches on centers, whichever is less.
 - 1. Fully Recessed Mullions: Where shown, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
 - 2. Semi-recessed Mullions: Where shown, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
 - 3. Exposed Mullions: Where shown, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
- G. Where shown, provide subsills made of same material as louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise shown or size of louver assembly makes bolted connections between frame members necessary.

2.4 FIXED, EXTRUDED ALUMINUM LOUVERS

- A. Furnish Six-inch fixed louvers where shown, or scheduled. Drainable blades shall incorporate a front lip gutter and recessed second gutter, both of which direct water to jamb and mullion drains.
- B. Free Area Velocity: Maximum 960 feet per minute free area velocity at a pressure drop of not more than 0.17-inches water gage carrying less than 0.01 ounces of water per square foot of free area.
- C. All blades shall be 0.081-inch thick. Provide all blades with integral drainage trough along edge of blades. Frame shall be 0.125-inches thick. Mullions shall be of the sliding interlock type.
- D. Free Area: Not less than 7.3 square feet for a 48-inch by 48-inch high louver.
- E. Provide louver supports designed to carry 32 pounds per square foot wind load.
- F. Install louver screen behind the louver.
- G. Products and Manufacturers: Provide one of the following:
 - 1. No. A6157 by Construction Specialties, Incorporated.
 - 2. No. K6776 by the Airolite Company.
 - 3. Or equal.

2.5 FINISHES

A. Anodized Finish:

1. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018-mm or thicker) complying with AAMA 611.

2.6 LOUVER SCREENS

- A. Provide removable screens for all louvers.
- B. Fabricate screen frames of the same metal and finish as the louver units to which secured. Provide frames consisting of extra heavy duty extruded 0.090-inch aluminum for permanently securing screen mesh. Frames shall be rewirable.
- D. Provide bird screen, 1/2-inch square stainless steel wire, 0.063-inch diameter wire.
- E. Locate screens on inside face of louvers. Secure screens to louver frames with machine screws, spaced at each corner and at 12-inches on centers.
- F. Provide minimum No. 8 stainless steel metal screws, unless larger screws are required by screen size.
- G. Provide cross bar screen reinforcement of same material and finish as louver which subdivides screens into maximum area of 50 square feet.

2.7 BLANK-OFF PANELS

- A. Insulated, Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets.
 1. Thickness: Two-inches.
 2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch, nominal thickness.
 3. Insulating Core: Rigid fiberglass board insulation.
 4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
 5. Seal perimeter joints between panel faces and louver frames with 1/8 by 1-inch PVC compression gaskets.
 6. Attach blank-off panels to back of louver frames with stainless steel clips and sheet metal screws.
 7. Provide blank-off panels at all louvers not being reused for ventilation purposes. Coordinate with 'H' drawings.

2.8 SILL EXTENSION

- A. Gage and Finish: Same as louver.

2.9 ATTACHMENT FRAME

- A. Gage and Finish: Same as louver.
- B. Size: As shown on the Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR and his installer must examine the areas and conditions under which louvers and vents Work and associated items are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the Site.

3.3 INSTALLATION

- A. Locate and place louver units plumb, level and in proper alignment with adjacent work.
- B. Use stainless steel expansion bolt anchors with stainless steel washers and neoprene gaskets. Use spring clips at all anchors to stop deflection of the louver frame. Provide anchors spaced 2 feet-0 inches on centers. Provide continuous aluminum angles for anchoring all operable louvers.
- C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as shown.
- D. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective Work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, as determined by ENGINEER.

- E. Protection of Aluminum from Dissimilar Materials: Coat all aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09 91 00, Painting.

3.4 FIELD QUALITY CONTROL

- A. Determine conformity of louver polyvinylidene fluoride finish to these Specifications, as follows:
 - 1. The manufacturer of the louver and vents shall set aside and label samples of the metal from each production lot for the job. Protect samples from weather.
 - 2. Make sample louver and vent available at all times, for comparison with installed louver and vent Work as requested by OWNER, for the full time of the warranty.
 - 3. Make color comparison measurements with a Hunter Tristimulus Color Difference Meter employing methods of computation in use at the National Bureau of Standards conforming to ASTM D 2224.

3.5 ADJUSTMENT AND CLEANING

- A. Set adjustable louver blades for uniform alignment in open and closed positions.
- B. Adjust louvers so moving parts operate smoothly.
- C. Check the motor operator installation for the operable louver.
- D. Louvers with dents, warps, gouges or scratches shall be replaced with new louvers, at no additional cost to OWNER.

++ END OF SECTION ++

SECTION 09 21 16

GYPSUM BOARD ASSEMBLIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install gypsum board assemblies. The Work also includes:
 - a. Providing openings in gypsum board assemblies to accommodate the Work under this and other Sections, and building into gypsum board assemblies all items to be embedded in or penetrate gypsum board assemblies.
2. Extent of gypsum board assemblies is shown.
3. Types of products required include:
 - a. Various types of interior wall and ceiling gypsum board.
 - b. Sound attenuation blankets.
 - c. Joint reinforcement and finish system.
 - d. Sealant system for restriction of air, sound, or smoke passage through joints.
 - e. Auxiliary materials, trim, and fasteners.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before gypsum board assemblies Work.
2. Coordinate furnishing and installing products for maintaining fire-resistance rating of gypsum board assemblies at perimeters and penetrations where built-in and recessed items and transitions with other building components occur in the Work.

C. Related Sections:

1. Section 07 21 05, Building Insulation.
2. Section 07 92 00, Joint Sealants.
3. Section 09 22 16, Non-Structural Metal Framing.
4. Section 09 91 00, Painting.
5. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI A108.11, Interior Installation of Cementitious Backer Units.

2. ANSI A118.9, Test Methods and Specifications for Cementitious Backer Units.
3. ASTM C11, Terminology Relating to Gypsum and Related Building Materials and Systems.
4. ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
5. ASTM C475/C475M, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
6. ASTM C514, Specification for Nails for the Application of Gypsum Board.
7. ASTM C665, Specifications for Mineral Fiber Blanket, Loose-Fill and Spray-Applied Insulation.
8. ASTM C754, Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
9. ASTM C834, Specification for Latex Sealants.
10. ASTM C840, Specification for Application and Finishing of Gypsum Board.
11. ASTM C919, Practice for Use of Sealants in Acoustical Applications.
12. ASTM C954, Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033-in. (0.84 mm) to 0.112-in (2.84mm) in Thickness.
13. ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Metal Studs.
14. ASTM C1047, Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
15. ASTM C1177/C1177M, Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
16. ASTM C1178/C1178M, Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.
17. ASTM C1396, Specification for Gypsum Board.
18. ASTM D578, Specification for Glass Fiber Strands.
19. ASTM D3273, Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
20. ASTM D4977, Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion.
21. ASTM D5034, Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).
22. ASTM D5035, Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method).
23. ASTM D5420, Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
24. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.
25. ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
26. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.

27. ASTM E413, Classification for Rating Sound Insulation.
28. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
29. ASTM E695, Test Method of Measuring Relative Resistance of Wall, Floor and Roof Construction to Impact Loading.
30. GA-214, Recommended Levels of Gypsum Board Finish.
31. GA-216, Application of Gypsum Board.
32. GA-235, Gypsum Board Typical Mechanical and Physical Properties.
33. GA-530, Design Data.
34. UL, Fire Resistance Directory.
35. USGBC LEED-NC, Reference Guide, For New Construction and Major Renovation.

1.3 DEFINITIONS AND TERMINOLOGY

- A. Definitions: The following terms are defined for this Section and supplement the terms defined in the General Conditions:
 1. Level of Finish: The designated finish of gypsum board assemblies established in ASTM C840.
- B. Terminology:
 1. Terminology used in this Section is in accordance with ASTM C11, ASTM C754 and ASTM C840.
 2. The following words or terms are not defined but, when used in this Section, have the following meaning:
 - a. “Critical lighting” is strong side lighting from windows or surface-mounted light fixtures.
 - b. “Joint photographing” is the shadowing of finished joint areas through the surface decoration.
 - c. “Drywall primer” is paint material specifically formulated to fill pores and equalize the suction difference between gypsum board surface paper and the compound used on finished joints, angles, fastener heads, and accessories and over skim coats.
 - d. “Skim coat” is thin coat or joint compound, or material manufactured especially for this purpose, applied over the entire surface to fill imperfections in the joint Work, smooth the paper texture, and provide a uniform surface for decorating. Excess compound shall be immediately sheared off, leaving a film of skim coating compound completely covering the paper.
 - e. “Spotting” is to cover fastener heads with joint compound.
 - f. “Texture” is decorative treatment on gypsum board surface.
 - g. “Texturing” is regular or irregular patterns typically produced by applying a mixture of joint compound and water, or proprietary texture materials including latex base texture paint, to a gypsum board surface previously coated with primer/sealer.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Provide gypsum board, accessories and trim manufactured by firms specializing in production of types of products specified, in compliance with reference standards listed in this Section.
 - b. Provide gypsum board assemblies manufactured by firms that are members of the Gypsum Association (GA) and participate in GA's certification programs.
2. Installer:
 - a. Engage a single installer that regularly performs gypsum board assemblies installation, with documented skill and successful experience in installing types of materials required; and that employs only tradesmen who are trained, skilled, and have successful experience in installing types of materials specified.
 - b. Submit name and qualifications with the following information for at least three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.
 - 2) Approximate contract cost of the gypsum board assemblies.
 - 3) Quantity (area) installed.

B Component Supply and Compatibility:

1. Furnish gypsum board assemblies materials from manufacturers who retains qualified technical personnel who will visit the Site for purpose of advising installer of proper procedures and precautions for using materials and who will assist ENGINEER with opinions on whether gypsum board assemblies Work conforms to the Contract Documents and manufacturer's recommendations.
2. Provide gypsum board assemblies materials from manufacturer who furnishes test certificates for published fire, sound, and structural data covering systems designed and constructed according to manufacturer's published specifications.
3. Furnish gypsum board assemblies materials from manufacturers whose products comply with GA-235.

C. Regulatory Requirements:

1. Where fire resistance classification (four-hour, three-hour, and similar designations) is shown or scheduled which includes gypsum board assemblies, provide components complying with applicable requirements for materials and installation established by UL and authorities having jurisdiction.
2. UL Compliance: Comply with UL Fire Resistance Directory for applicable fire-resistant construction systems.
3. Vibration, Seismic and Wind Controls: The Work shall conform to seismic, vibration and wind requirements in Section 40 05 96, Vibration, Seismic,

and Wind Controls. Support system shall conform to Laws and Regulations, including building code referred to in Section 01 42 00, References. Refer to Section 01 45 33.00CAOH, Code-Required Special Inspections and Procedures.

4. Comply with 40 CFR 59, Subpart D, National Volatile Organic Compound Emission Standards for Architectural Coatings.

D. Mock-Ups:

1. Before proceeding with purchasing materials and installing gypsum board assemblies and after ENGINEER's approval of Samples and other submittals, install 100 square foot Samples of each type of gypsum board assembly, including accessory trim, framing specified in Section 09 22 16, Non-Structural Metal Framing, insulation specified in Section 07 21 05, Building Insulation, built-in items that may be specified in other Sections, Work under Section 09 30 13, Ceramic Tiling, as applicable, and Section 09 91 00, Painting, and decorative finishes specified in this Section indicating the final relationship and configurations of various parts and components and quality of workmanship to be achieved in the Work. Locate mock-ups in areas selected by ENGINEER to indicate representative installation of each type of gypsum board assembly.
2. Simulate finished lighting conditions for mock-up review.
3. Incorporate materials and methods of installation that are identical to Project requirements.
4. Obtain ENGINEER's approval of visual qualities of mock-up before starting installation of gypsum board assemblies. Retain and protect mock-up during construction as a standard for judging completed gypsum board assemblies Work. Do not alter or remove approved mock-ups.
5. Build as many mock-ups as required to obtain ENGINEER's approval. Disassemble rejected mock-ups and remove components from the Site. Do not incorporate rejected mock-up components into the Work. Approved mock-up may be incorporated into the Work.
6. Do not commence gypsum board assemblies installation without obtaining ENGINEER's approval of associated mock-up.
7. Remove and replace with new material gypsum board assemblies that do not meet standard of workmanship on the approved mock-up.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Show locations, fabrications, and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other units of Work.
2. Product Data:
 - a. Manufacturer's product data, specifications, and performance data for gypsum board assembly component required. Indicate compliance

with requirements of reference standards included in this Section and requirements of authorities having jurisdiction.

- b. Include copies of certified test reports and other data as may be required to show compliance with the Contract Documents, including specified performance characteristics and physical properties.
 - c. Submit UL Design Numbers, descriptions of fire-resistive construction systems and of each proposed fire-resistive system component.
 - d. Manufacturer's design criteria for transverse loading capabilities of system assemblies indicating compliance with requirements of authorities having jurisdiction at the Site, for unbraced supported partition heights shown and system performance criteria specified.
3. Samples: Sample submittals will be reviewed by ENGINEER for color, texture and pattern only. Compliance with all other requirements is the responsibility of CONTRACTOR. Submit the following:
- a. Full-size Sample, each 12-inch long, for each trim accessory used in the Work.
 - b. Mock-up(s).

B. Informational Submittals: Submit the following:

- 1. Certificates.
 - a. Certificates signed by manufacturer stating that materials meet or exceed requirements of the Contract Documents, including performance characteristics and criteria and physical requirements, and stating that materials have been provided as specified to meet fire-resistance-ratings, thickness requirements, and application requirements.
- 2. Supplier Instructions:
 - a. Step-by-step joint treatment installation instructions for each Level of Finish specified for each area of the Work.
- 3. Site Quality Control Submittals:
 - a. Results of specified inspections and observations.
 - b. Refer to Section 01 45 33 Code-Required Special Inspections and Procedures for reporting requirements.
- 4. Qualifications Statements:
 - a. Manufacturer, when required by ENGINEER.
 - b. Installer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Comply with applicable requirements of reference standards used in this Section, Section 01 65 00, Product Delivery Requirements, and Section 01 66 00, Product Storage and Handling Requirements

1.7 PROJECT CONDITIONS

- A. Environmental Requirements:

1. Temperature: Comply with the more stringent of ASTM C840 and manufacturer's written recommendations.
2. Ventilation:
 - a. Provide ventilation during and following application of adhesives and joint treatments.
 - b. Use temporary air circulators in enclosed areas that lack natural ventilation.
 - c. Under slow drying conditions, allow additional drying time between coats of joint treatment.
 - d. Protect installed materials from drafts during hot, dry weather.
3. Do not install panels that are any of the following: wet, moisture damaged, or mold damaged.
 - a. Indications that panels are wet or moisture damaged includes, but is not limited to, discoloration, sagging, or irregular shape.
 - b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.8 SEQUENCING

- A. Prior to starting installation of gypsum board, coordinate Work requiring openings, chases, frames, access panels, support, and similar integrated requirements, including heating and ventilating and electrical work.
- B. Do not proceed with gypsum board installation until blocking, framing, bracing, and other supports for subsequently applied Work are installed.
- C. Do not install gypsum board until thermal insulation to be concealed by board has been installed.
- D. Install sound attenuation blankets where indicated and where required to achieve STC ratings or fire-resistance ratings, before installing gypsum board, unless blankets can be readily installed after board has been installed.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Description:
 1. Gypsum board assemblies include finishing systems for walls, columns and ceilings that consists of panels with various types of specially treated, hydrated calcium sulfate cores reinforced with paper laminated to both faces of panels and manufactured for direct application of decorative finishes, including a joint treatment system known as self-setting drywall finishing and other drywall trim system accessories, and a system of metal studs, furring and bracing.

2. Complete systems shall conform to combined performance criteria in the Contract Documents.
 3. Recycled Content: Provide gypsum panel products with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes minimum of:
 - a. Gypsum: 25 percent by weight.
 - b. Paper: 100 percent.
 4. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Performance Criteria:
1. General:
 - a. Standards: Comply with GA-530 and ASTM standards specified in this Section, except when more-stringent requirements are mandated by authorities having jurisdiction.
 2. Level of Finish for Gypsum Board Assemblies: In accordance with ASTM C840, provide the Level of Finish for all gypsum board assemblies indicated in Paragraph 3.6.A.5 of this Section.
 3. Fire-Test-Response Characteristics of Gypsum Board Assemblies: For gypsum board assemblies with fire-resistance-ratings, provide materials and construction identical to those tested in assemblies by an independent testing and inspecting agency acceptable to authorities having jurisdiction at the Site, and in compliance with ASTM E119.
 - a. Fire-Resistance-Rating: As shown or indicated on the Contract Documents, conforming to UL Fire Resistance Directory.

2.2 MANUFACTURERS

- A. Gypsum Board Products, Accessories and Trim: Provide products as manufactured by one of the following:
1. Gold Bond Building Products, by National Gypsum Company.
 2. ToughRock Products, by G-P Gypsum Corporation.
 3. SHEETROCK Brand Products, by United States Gypsum Company, Subsidiary of USG Corporation.
 4. Or equal.
- B. Metal Support System Components: Refer to Section 09 22 16, Non-Structural Metal Framing.

2.3 SUSPENDED CEILING AND SOFFIT FRAMING

- A. Refer to Section 09 22 16, Non-Structural Metal Framing.

2.4 INTERIOR GYPSUM BOARD

- A. Exposed Gypsum Board: Provide the following types of interior gypsum board with two edge configurations where available from manufacturers specified; with

100 percent recycled paper on front, back, and long edges bonded to the core; complying with ASTM C1396:

1. Panel Size: Provide all panels in maximum lengths and widths available that minimize joints in each area and correspond with spacing of support system components.
2. Surface Burning Characteristics, ASTM E84: Flame Spread: 15, Smoke Development: Zero.
3. Fire-Rated Gypsum Board: Gypsum core wall panel with additives to enhance fire resistance of the core and surfaced with paper on front, back, and long edges, Type X.
5. Extended Fire-Rated Gypsum Board: Gypsum core wall panel with additives to enhance fire resistance (greater than Type X) of the core and surfaced with paper on front, back, and long edges, Type C.
15. Thickness: 5/8-inch, except 1/2-inches for regular gypsum board and 1/4-inch for double layer installations and flexible gypsum board.
16. Long-Edge Profile: Tapered.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475.
- B. High-Strength Joint Reinforcing Tape for Exterior and Interior Applications: Fiberglass, self-adhering, two inches wide, in compliance with ASTM D578, ASTM D5034, and ASTM D5035.
- C. Joint Compound for Exterior and Interior Applications: Provide dry-powder, sandable, self-setting chemical hardening compounds for all gypsum board assemblies. Work, recommended by manufacturer as being unaffected by humidity after hardening and drying.
 1. For each coat use formulation compatible with other compounds applied previously, and compatible with successive coats.
 2. Provide special chemical-hardening-type, slow-setting, or regular-setting-type compounds for gypsum board assemblies.
 - a. Prefilling: At open joints, rounded panel edges, and damaged surface areas, use setting-type taping compound.
 - b. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges use setting-type taping compound.
 - c. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - d. Finish Coat: For third coat, use setting-type, sandable topping compound.
 - e. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
- D. Joint Compound for Tile Backing Panels:
 1. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
3. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.6 TRIM ACCESSORIES

- A. General: Comply with ASTM C1047.
- B. Products: Provide manufacturer's standard trim accessories of types shown or indicated for gypsum board assemblies, formed of hot-dipped galvanized steel or zinc, with either knurled and perforated or expanded flanges for nailing or stapling, and beaded for concealment of flanges in joint compound. Provide corner beads, L-type edge trim-beads, U-type edge trim-beads, special L-kerf-type edge trim-beads, J-type wallboard casings and one-piece control joint beads.
 1. Finishing Type: Manufacturer's standard trim units to be finished with joint compound.

2.7 GYPSUM BOARD FASTENERS

- A. Gypsum Board Fasteners: Comply with GA-216, and with gypsum board manufacturer's recommendations; choice is installer's option where more than one type is recommended for application specified.
 1. Annular Ring Nail: ASTM C514.
 2. Smooth Shank Nail: ASTM C514.
 3. Steel Drill Screws: Self-drilling, self-tapping, bugle-head complying with ASTM C954 and ASTM C1002, for use with power-driven tools.
 - a. Type S for wallboard to sheet metal.
 - b. Type W for wallboard to wood.
 - c. Type G for wallboard to wallboard.

2.8 SOUND ATTENUATION

- A. Sound Attenuation Blankets: Semi-rigid, friction-fit, spun mineral fiber blanket complying with ASTM C665, Type 1 (blankets without membrane facing); flame-spread, smoke and fuel contributed ratings of less than 25; manufactured by combining thermosetting resins with mineral fibers obtained from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 2. Recycled Content: Provide blankets with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes minimum of 25 percent by weight.

2.9 AUXILIARY MATERIALS

- A. Laminating Adhesive: Setting-type, for directly adhering gypsum boards to continuous substrate. Use adhesives that have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Water-resistant Sealant: Type recommended by gypsum board manufacturer for sealing cut edges and holes in water-resistant gypsum board. Provide sealants that have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Isolation Strips: Adhesive-backed, closed-cell, vinyl foam strips that allow fastener penetration without foam displacement, 1/8-inch thick in width to suit stud size.
- D. Thermal Insulation: Refer to Section 07 21 05, Building Insulation.
- E. Vapor Barrier: Refer to Section 07 21 05, Building Insulation.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine substrates and spaces to receive gypsum board assemblies, and conditions under which gypsum board assemblies will be installed, and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Verify that spacing of installed, non-load-bearing steel framing does not exceed maximum allowable for types of gypsum board assemblies approved for the Work.
- B. Verify that doorframes are set for thicknesses of gypsum board shown on approved Shop Drawings and in the Contract Documents.
- C. Repair protrusions of framing, twisted framing members, and unaligned members before commencing gypsum board installation.
- D. Protect adjacent surfaces against damage and stains.

3.3 INSTALLATION OF METAL SUPPORT SYSTEMS

- A. Refer to Section 09 22 16, Non-Structural Metal Framing.

3.4 INSTALLATION OF GYPSUM BOARD

A. General:

1. Standards: Comply with ASTM C840. Comply with requirements for fire resistance-ratings and STC-ratings shown.
2. Provide sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
3. Provide ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
4. Provide gypsum panels with face side out. Butt panels together for light contact at edges and ends with not more than 1/16-inch of open space between panels. Do not force into place.
5. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Do not make joint other than control joints at corners or framed openings.
6. Attach gypsum board to steel studs and blocking so leading edge or end of panel is attached to open (unsupported) edges of stud flanges first.
7. Attach gypsum panels to framing provided at openings and cutouts.
8. Cut back paper; do not tear or snap.
9. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
10. Control Joints: Form control joints and expansion joints with 1/2-inch continuous opening between edges of adjacent boards for insertion of control joint trim accessory. Provide control joints as shown; if not otherwise shown or indicated, provide at the following locations:
 - a. Ceilings:
 - 1) Areas exceeding 2,500 square feet.
 - 2) Not more than 50 feet on centers.
 - 3) Where ceiling framing or furring changes direction.
 - 4) In furred assemblies where control joints occur in structural ceiling.
 - 5) Where expansion joints occur in steel framing.
 - b. Walls:
 - 1) In partitions and wall furring runs exceeding 30 feet.
 - 2) Not more than 30 feet on centers.
 - 3) In furred assemblies where control joints occur in base exterior wall.
 - 4) Where expansion joints occur in steel framing.
 - c. Do not locate joints within eight inches of corners or openings, except where control joints are shown at jamb lines or where openings occur adjacent to corners in partition/wall layout. Where necessary, provide a single vertical joint over center of wide openings.

11. Provide gypsum board on both faces of steel stud partition framing above ceilings and in similar concealed spaces, except in chase walls that are properly braced internally.
 - a. Where partitions in concealed spaces are not required for STC-ratings, fire resistance-ratings, or control of air distribution, smoke or heat, studs may be faced with scraps of gypsum board applied in a single layer. Apply each piece with two or more screws in each stud, 12-inch maximum screw spacing. Cover at least 75 percent of each face.
 12. Provide perimeter isolation where non-load-bearing partitions abut structural decks or ceilings, or vertical structural elements. Allow not less than 1/4-inch, or more than 1/2-inch gap between gypsum and structure. Finish edges of face layer with J-Type (semi-finishing) casing bead. Seal space between casing bead and structure with continuous acoustical sealant bead. Attach gypsum board to studs not less than 1/2-inch below bottom edge of ceiling track flanges and to first stud adjacent to vertical tracks. Do not attach board directly to tracks.
 13. Where concrete columns are to be enclosed with gypsum board assemblies, provide freestanding vertical steel stud furring as required supporting gypsum board with not less than 1/2-inch clearance between concrete and furring, and between concrete and gypsum board.
 14. Floating Construction: Where feasible, and recommended by manufacturer, provide gypsum board with "floating" internal corner construction, unless isolation of intersecting boards or control or expansion joints are shown.
- B. Space fasteners in gypsum panels according to manufacturer's written recommendations and reference standards used in this Section.
1. Space screws maximum of 12 inches on centers for vertical applications.
 2. Space fasteners in panels that are ceramic tile substrates a maximum of eight inches on centers.
- C. Panel Installation Methods:
1. General: In addition to complying with reference standards used in this Section, comply with specific requirements indicated for each type or arrangement of gypsum board assembly shown.
 2. Single-Layer Applications:
 - a. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible, and at right angles to framing, unless otherwise shown or indicated.
 - b. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise shown or required by fire-resistance-rated assembly, and minimize end joints.
 - 1) Stagger abutting end joints not less than one framing member in alternative courses of board.
 - 2) At stairwells and other high walls, provide panels horizontally (perpendicular to framing), unless otherwise shown or required by fire-resistance-rated assembly.

- c. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate end joints over furring members.
- d. For parallel applications, locate edge joints over supports; for right angle applications, stagger end joints over supports.
- e. Apply gypsum panels to supports with steel drill screws.
- 3. Multi-Layer Applications:
 - a. On ceilings, apply gypsum board base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise shown or required by fire-resistance-rated assembly.
 - b. On partition/walls, apply gypsum board base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise shown or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - c. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
 - d. Laminate face layer to base layer with laminating adhesive and supplemental permanent screw fasteners penetrating through base layer and into supports. Apply in direction which results in minimum end joints, and offset joints (both directions).
 - e. Apply gypsum panels to supports with steel drill screws.
- 4. Direct-Bonding to Substrate: Where gypsum board is shown or indicated to be directly laminated to substrate, other than studs, joists, furring members or base layer of gypsum board, comply with gypsum board manufacturer's recommendations, and temporarily brace or fasten gypsum board until laminating adhesive has set.
- 5. Areas Not Subject to Wetting: Install regular-type gypsum wallboard panels to produce flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.

D. Allowable Tolerances:

- 1. Gypsum Board Faces: 1/16-inch offsets between planes of board faces, and 1/8-inch in eight feet for plumb, level, warp, and bow.
- 2. Suspended Ceilings: Level main carrying channels to 1/8-inch in 12 feet measured lengthwise on each member and transversely between parallel members.

3.5 INSTALLATION OF TRIM ACCESSORIES

- A. General: Provide trim accessories in accordance with ASTM C840. Coordinate, and integrate where possible installation of trim accessories with installation of gypsum board. Use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to supports. Otherwise, fasten flanges by nailing in accordance with manufacturer's written instructions.
- B. Install metal corner beads at external corners of gypsum board assemblies.
- C. Install metal edge trim where edge of gypsum board would otherwise be exposed or semi-exposed.
 - 1. Provide L-Type trim-beads, for joint compound, where edge is shown to be tightly fitted to abutting Work, without reveal or sealant pocket.
 - 2. Provide U-Type trim-beads, for joint compound, where edge is not tightly fitted to abutting Work, or is exposed, revealed with sealant pocket, gasketed, or with other separation, except as otherwise shown.
 - a. Provide special kerf-type I-trim where adjoining Work is kerfed to receive leg of trim unit.
 - 3. Provide J-Type semi-finishing trim, not for joint compound, at the following locations and where shown:
 - a. Edges of exterior gypsum board not covered by applied moldings.
 - b. On interior wall panels of exterior walls at juncture with ceilings.
 - c. At sealant-filled isolation joints and sound control joints, where gypsum drywall work abuts other construction including walls and ceilings.
 - d. At sealant-filled or gasket-filled building expansion joints, install back-to-back units spaced as shown or, if not shown, at 1/4-inch spacing.
- D. Install control joint bead units where control joints are shown.
- E. Miter corners of exposed molding and trim (semi-finishing) units. Align joints and support to eliminate offsets.

3.6 FINISHING OF GYPSUM BOARD ASSEMBLIES

- A. General:
 - 1. Comply with GA-214 and finishing materials manufacturer's written instructions for mixing, handling, and applying materials. Machine- or hand-application is installer's option.
 - 2. Apply treatment at joints in both directions, flanges of trim accessories, but not semi-finishing types, gypsum board penetrations, electrical boxes, piping and similar work, fastener heads, surface defects, and elsewhere as shown or specified. Apply in manner that will result in each of these being concealed when applied decoration has been completed.

3. Where open joints of more than 1/16-inch occur, including edges of boards with rounded or beveled corners, prefill joint with chemical-hardening-type bedding compound, prior to bedding of joint tape.
4. Apply joint tape at joints between gypsum boards, except where trim accessory is shown.
5. Level of Finish for Gypsum Board: As established by ASTM C840, provide the following Level of Finish for all gypsum board assemblies:
 - a. Level 4: All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over flat joints and one separate coat of joint compound applied over interior angles. Cover fastener heads and accessories with three separate coats of joint compound. Joint compounds shall be smooth and free of tool marks and ridges. Coat all prepared surfaces with drywall primer prior to applying final finish. Coordinate with Section 09 91 00, Painting. Provide for the following areas:
 - 1) All areas.
6. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
7. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.
8. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 APPLYING TEXTURED FINISHES

- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving textured finishes. Apply primer to surfaces that are clean, dry, and smooth.
- B. Textured Finish Application: Mix and apply finish using powered spray equipment recommended by textured finish materials manufacturer to provide uniform texture free of starved spots and other evidence of thin application, and without indicating application pattern.
- C. Prevent textured finishes from contacting surfaces not shown to receive textured finish by covering them with masking agents, polyethylene film, or other effective means of protecting surfaces not identified to receive textured finish. If, despite these precautions, textured finishes contact surfaces not designated to receive textured finish, immediately remove droppings and overspray according to textured finish manufacturer's written recommendations.

3.8 FIELD QUALITY CONTROL

- A. Before installing gypsum board ceilings, inspect ceiling support framing accompanied by ENGINEER and submit written report of deficiencies. Do not proceed with installing gypsum board on ceiling support framing until deficiencies are corrected.

1. Notify ENGINEER ten days in advance of the date and time when Work, or part of Work, will be ready for above ceiling observation.
 2. Before notifying ENGINEER, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation of insulation, and successful testing of piping conveying fluids and automatic fire suppression system.
 - c. Installation of ventilation duct system.
 - d. Installation of air distribution devices.
 - e. Installation of ceiling support framing.
- B. Special Inspections: Coordinate with the Coordinating Special Inspector. Refer to Section 01 45 33, Code-Required Special Inspections and Procedures, for requirements.

3.9 ADJUSTING AND CLEANING

- A. Nail Pop:
1. Repair nail pop by driving new nails approximately 1.5 inches from popped nail and reseal nail.
 2. When face paper is punctured, drive new nail or screw approximately 1.5 inches from defective fastening and remove defective fastening.
 3. Fill damaged surface with self-setting joint filler compound.
- B. Ridging:
1. Do not repair ridging until condition has fully developed, approximately six months after installation or one heating season.
 2. Sand ridges to reinforcing tape without cutting through tape.
 3. Fill concave areas on both sides of ridge with topping compound.
 4. After fill is dry, blend in topping compound over repaired area. Fill cracks with compound and finish smooth and flush.
 5. Installer shall advise CONTRACTOR, who shall advise ENGINEER, of required procedures for protecting completed gypsum board assemblies from damage and deterioration during remainder of construction. CONTRACTOR shall provide required protection.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE++

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, professional services, and incidentals as shown, specified, and required to furnish and install non-structural metal framing. The Work also includes:
 - a. Providing openings in non-structural metal framing to accommodate the Work under other Sections and building into non-structural metal framing items such as sleeves, anchorage devices, inserts, and all other items to be embedded in non-structural metal framing for which placement is not specifically provided under other Sections.
2. Provide the following types of products:
 - a. Interior steel stud partition systems.
 - b. Furring members.
 - c. Auxiliary products.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before non-structural metal framing Work.
2. Coordinate furnishing and installing products for maintaining fire-resistance rating of non-structural metal framing at perimeters and penetrations where built-in and recessed items, and transitions with other building components, occur in the Work.

C. Related Sections:

1. Section 06 10 53, Miscellaneous Rough Carpentry.
2. Section 09 24 00, Portland Cement Plastering.
3. Section 09 21 16, Gypsum Board Assemblies.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A366/A366M, Specification for Commercial Steel Sheet, Carbon (0.15 Maximum Percent), Cold-Rolled.
3. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.

4. ASTM A570/A570M, Specification for Structural Steel, Sheet and Strip, Carbon, Hot-Rolled.
5. ASTM A641/A641M, Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
6. ASTM A645/A645M, Specification for Pressure Vessel Plates, Five Percent Nickel Alloy Steel, Specially Heat Treated
7. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM C645, Specification for Nonstructural Steel Framing Members.
9. ASTM C754, Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
10. ASTM C840, Specification for Applying and Finishing Gypsum Board.
11. ASTM C841, Specification for Installation of Interior Lathing and Furring.
12. ASTM C955, Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
13. ASTM C1063, Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
14. ASTM D226, Specification for Asphalt-saturated Organic Felt Used in Roofing and Waterproofing.
15. ASTM E90, Test Methods for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
16. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
17. ASTM E413, Classification for Rating Sound Insulation.
18. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
19. ISO 9002, Quality Systems – Model for Quality Assurance in Production, Installation and Servicing.
20. UL, Fire Resistance Directory.
21. USGBC, LEED-NC, LEED Reference Guide, For New Construction and Major Renovation.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Provide non-structural metal framing, furring and auxiliary products and accessories manufactured by firms specializing in producing types of products specified, in compliance with the Contract Documents.
 - b. Provide non-structural metal framing, furring and auxiliary products and accessories manufactured by firms that are members of ML/SFA and AWCI, and participate in certification programs.
 - c. Obtain materials from manufacturers who will, when required, furnish services of qualified technical representative at the Site, for purpose of

advising installer of proper procedures and precautions for using the materials.

- d. Provide products from manufacturers who participate in ISO 9002 Quality Control Programs.

2. Professional Engineer:

- a. Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Site is located and experienced in providing engineering services of the kind indicated.
- b. Submit qualifications data.
- c. Responsibilities include but are not necessarily limited to:
 - 1) Carefully reviewing non-structural metal framing performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising preparation of design calculations and related drawings, Shop Drawings, interpretation of quality control results, and a comprehensive engineering analysis verifying compliance of the non-structural metal framing with the requirements of the Contract Documents.
 - 4) Signing and sealing all calculations and design drawings, and Shop Drawings.
 - 5) Certifying that:
 - a) It has performed the design of the non-structural metal framing in accordance with performance and design criteria stated in the Contract Documents, and the said design conforms to Laws and Regulations, and to the prevailing standards of practice.

3. Installer:

- a. Engage a single installer regularly performing non-structural metal framing and furring installation, and with documented skill and successful experience in installing types of materials required; and who employs only tradesmen who are trained, skilled, and have successful experience in installing types of materials specified.
- b. Submit name and qualifications with the following information for at least three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for each project.
 - 2) Approximate contract cost of non-load-bearing steel framing.
 - 3) Quantity (area) installed.

B. Component Supply and Compatibility:

- 1. Furnish all components of non-structural metal framing and furring from a single manufacturer, and from a single supplier, where possible, with adequate resources to provide products of consistent performance characteristics, physical properties and appearance, without delaying the Work.

C. Regulatory Requirements:

1. Where fire-resistance classification (four-hour, three-hour and similar designations) is shown or indicated which includes non-load-bearing steel framing, provide components complying with applicable requirements for materials and installation established by UL and authorities having jurisdiction at the Site.
2. UL Compliance: Comply with UL Fire Resistance Directory for applicable fire-resistant construction systems.
3. Vibration, Seismic and Wind Controls: The Work shall conform to seismic, vibration and wind requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls. Support system shall conform to Laws and Regulations, including building code referred to in Section 01 42 00, References. Refer to Section 01 45 33, Code-Required Special Inspections and Procedures.

D. Mock-Ups:

1. Prior to installing non-structural metal framing, but after ENGINEER'S approval of Samples and Shop Drawings, install a 100 square foot mock-up, in area selected by ENGINEER, using materials and workmanship demonstrating proposed range of color, texture and allowable tolerances to be expected in the completed Work. Obtain ENGINEER's approval of color, texture and tolerances before proceeding with the Work. Compliance with other requirements is responsibility of CONTRACTOR. Do not alter, move or destroy mock-up panels until corresponding plaster and gypsum board Work is acceptably completed.
2. Approved mock-ups may become part of the completed Work if approved mock-ups remain undamaged and undeteriorated at Substantial Completion.
3. Remove and replace with new material non-structural metal framing Work that does not meet the standard approved on mock-up panels.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Drawings locating all hangers and support anchors for suspension. Include locations of all accessories and framing components; and location of control joints based on the Contract Documents.
2. Product Data:
 - a. Manufacturer's product data and specifications for each item and each system specified.
 - b. Test Reports: Certified test reports on materials identical to those to be furnished demonstrating compliance with specified performance characteristics and physical properties
 - c. Include reports and other data as may be required to show compliance with the Contract Documents.
3. Delegated Design Submittals:
 - a. Calculations for complete structural analysis of non-structural metal framing systems including calculations showing compliance with

system performance criteria specified. Calculations shall be signed and sealed by professional engineer. Professional engineer's seal shall be clearly legible, including state of registration, registration number, and name on seal.

4. Samples:
 - a. Twelve-inch lengths of non-load-bearing steel framing.
 - b. Twelve-inch length of wire hanger, rod, or strap.
 - c. Each type of insert or attachment device.
 - d. Twelve-inch lengths of each auxiliary system component.
 - e. Mock-up(s).
- B. Informational Submittals: Submit the following:
1. Certificates.
 - a. Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria, and physical requirements.
 2. Supplier Instructions:
 - a. Manufacturer's installation instructions for each material specified
 3. Site Quality Control Submittals:
 - a. Results of inspection upon completion of installation.
 - b. Refer to Section 01 45 33.00, Code-Required Special Inspections and Procedures, for reporting requirements.
 4. Qualifications Statements:
 - a. Manufacturer, when required by ENGINEER.
 - b. Professional engineer.
 - c. Installer.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Design Criteria:
1. Limiting Heights of Walls: Comply with ASTM C754 and ASTM C955 based on loading requirements according to Laws and Regulations and authorities having jurisdiction at the Site, and lateral pressure of five psf. Limit deflection of gypsum board assemblies to L/240.
 2. Vibration and Seismic Controls: Support system shall conform to Laws and Regulations including building code referred to in Section 01 42 00, References. Refer to Section 01 45 33, Code-Required Special Inspections and Procedures, and Section 40 05 96, Vibration, Seismic, and Wind Controls
 3. Concrete Inserts: Size anchorage devices for ceiling hangers for five times supported load, unless requirements that are more stringent are required by Laws and Regulations or required by authorities having jurisdiction.
 4. Fabricator is responsible for structural analysis and detailing of non-structural metal framing curtain wall system. Submit complete structural

calculations and verification of other system performance criteria at same time as Shop Drawings submittal, for all non-structural metal framing members, anchorage devices, and all other support from manufacturer's certified load tables signed and sealed by professional engineer.

5. Fire-Test-Response Characteristics of Non-Structural Metal Framing: For non-load-bearing steel framing with fire-resistance-ratings, provide materials and construction identical to those tested in assemblies by an independent testing and inspecting agency acceptable to authorities having jurisdiction, and complying with ASTM E119.
 - a. Fire-Resistance-Rating: As shown or indicated in the Contract Documents.

2.2 MANUFACTURERS

- A. Non-Structural Metal Framing Components and Accessories: Provide products of one of the following:
 1. Dietrich Metal Framing, Inc.
 2. Marino\Ware, Division of Ware Industries, Inc.
 3. Or equal.

2.3 MATERIALS

- A. General:
 1. Manufacturer's Recommendations: Except where otherwise required to comply with requirements of authorities having jurisdiction or where more stringent requirements are shown or specified, provide type, weight, grade and finish of materials recommended by manufacturer, and include for each system clips, fasteners, ties, reinforcing, stiffeners, shoes, tracks, hangers, brackets, anchors, trim, and accessories as recommended by manufacturer for the application shown or indicated.
 2. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.
 3. Metal and Finishes: Manufacturer's standard for steel products, unless otherwise shown or indicated as solid zinc alloy or other metal. Provide manufacturer's standard galvanized finish on steel products.
- B. Interior Metal Stud System Materials:
 1. Studs and Runners: ASTM C645, formed C-shaped steel channels of 0.0312-inch thick, base metal minimum, steel with 1.75-inch flange depth as shown, 40,000 psi steel complying with ASTM A653.
 2. Slip-type Head Joints:
 - a. Single Long-Leg Runner System: ASTM C645 top runner with two-inch deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of top of studs to provide lateral bracing.

- b. Double-Runner System: ASTM C645 top runners, inside runner with two-inch deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
 - c. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - d. Product and Manufacturer: Provide one of the following:
 - 1) VertiClip SLD and VertiTrack Series by VTD Steel Network Inc.
 - 2) Superior Flex Track System (SFT) by Superior Metal Trim.
 - 3) Or Equal.
 - 3. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Fire Trak with Fire Trak Slip Clip by Fire Trak Corporation.
 - 2) The System by Metal-Lite, Inc.
 - 3) Or Equal.
 - 4. Stiffeners: 0.0538-inch minimum base metal thickness, 3/4-inch by 1/2-inch, cold-rolled channel. Provide rust-inhibitive paint finish.
 - 5. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated 0.0312-inch minimum base metal thickness.
 - 6. Cold-Rolled Channel Bridging: 0.0538-inch minimum base metal thickness, with minimum 1/2-inch- wide flanges, 1.5 inches deep.
 - a. Clip Angle: Not less than 1.5 by 1.5 inches, 0.068-inch, minimum base metal thickness, galvanized steel.
- C. Wall/Partition Metal Furring Materials:
- 1. Channel Furring: 0.0538-inch minimum base metal thickness, 3/4-inch by 1/2-inch, cold-rolled channel. Provide rust-inhibitive paint finish.
 - 2. Hat Shaped Rigid Furring Channels, ASTM C645: 0.0312-inches, minimum base metal thickness, 1.5-inches deep, screw-type hat-shaped section.
 - 3. Resilient Furring Channels, ASTM C645: 0.0312-inches, minimum base metal thickness, 1/2-inch deep, screw-type hat-shaped section.
 - a. Resilient-Type: Where shown or indicated as “resilient”, provide manufacturer’s special hat-shaped rigid furring channels designed to reduce sound transmission.
 - 4. Furring Brackets: 0.0312-inch minimum base metal thickness, serrated-arm type, adjustable from 1/4-inch to 2.25-inch wall clearance for channel furring.
 - 5. Tie Wire: ASTM A641, Class 1 zinc coating, soft temper, 0.0625-inch minimum base metal diameter wire, or double strand of 0.0475-inch minimum base metal diameter wire.
 - 6. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1.25-inches, wall attachment flange of 7/8-inch, minimum base metal thickness of 0.0179-inch, and depth required to fit insulation thickness indicated.

D. Auxiliary Products and Trim:

1. General: Provide auxiliary materials that comply with installation requirements in the Contract Documents.
 - a. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
2. Isolation Strip at Exterior Walls: Provide one of the following:
 - a. Asphalt-Saturated Organic Felt: ASTM D226, Type I No. 15 asphalt felt.
 - b. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8-inch thick, in width to suit steel stud size.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine substrates and conditions under which non-structural metal framing Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Anchorages: Coordinate Work with structural ceiling Work to ensure that inserts and other structural anchorage provisions are installed to receive hangers.
- B. Maintain environmental conditions, including temperature, humidity, and ventilation, within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

3.3 INSTALLATION, GENERAL

- A. General: Comply with ASTM C754, except where framing sizes and spacing are indicated in the Contract Documents.
 1. Gypsum Plaster Assemblies: Comply with ASTM C841 relative to framing installation.
 2. Cement Plaster Assemblies: Comply with ASTM C1063 relative to framing installation.
 3. Gypsum Board Assemblies: Comply with ASTM C840 relative to framing installation.

- B. Allowable Tolerances:
 - 1. For flat surfaces, do not exceed 1/8-inch in twelve feet for bow, warp, plumb and level.
 - 2. For curved surfaces, do not exceed 1/8-inch in eight feet for bow, warp, plumb and level.
- C. Isolation: Where non-structural metal framing system abuts building structure horizontally, and where partitions abuts overhead structure, isolate the Work from structural movement sufficiently to prevent transfer of loading into non-structural metal framing and support framing from the building structure. Install slip or cushion type joints to absorb deflections but maintain lateral support.
 - 1. Frame both sides of control and expansion joints independently, and do not bridge joints with non-structural metal framing or auxiliary system components.
 - 2. Locations: Provide control joints as shown or, if not shown or indicated, at the following locations:
 - a. Walls and Ceilings:
 - 1) Where framing and furred assemblies cross expansion joints in substrates.
- D. Fixture Support Framing: Install supplementary framing, blocking, and bracing where non-structural metal framing Work is shown or indicated, to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar Work requiring attachment and support.
- E. Wire Tying: Except as otherwise shown or indicated, tie interior furring with 16-gage or double 18-gage wire; tie interior lath with 18-gage wire and tie exterior furring with 14-gage or double 16-gage wire; and tie exterior lath with 16-gage wire.
- F. Splicing Members: Lap furring members eight inches and runner channels 12 inches, and wire-tie near each end of lap. Lap light-gage studs 12 inches and install screws in both flanges near each end of lap. Splice plastering accessories by using concealed splines, anchored to prevent offsets.

3.4 SUSPENSION SYSTEMS

- A. Space runner channels as shown; if not shown space at four feet on centers.
- B. Install hangers supported only from building structural members. Locate hangers near each end and spaced four feet along each channel or direct-hung runners, unless otherwise shown or indicated.
- C. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system.

- D. Where width of ducts and other obstructions within ceiling plenum produces hanger spacing that interfere with location of hangers required to support standard suspension system members, provide supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established in reference standards and publications referred to in this Section, and designed by a professional engineer.
- E. Fire-resistive-Rated Assemblies: Wire tie furring channels to supports.
- F. Seismic: Comply with Section 40 05 96, Vibration, Seismic, and Wind Controls.

3.5 STUD SYSTEMS

- A. General: Comply with ASTM C645 and ASTM C754. Install steel studs with continuous runner tracks at top and bottom of each wall/partition area, and above and below each opening more than two feet wide. Anchor tracks to floor and overhead structure at each end and two feet on centers, maximum, unless otherwise shown.
- B. Terminate partition stud system at ceiling line, except extend system to structure above, where shown.
- C. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
- D. Space studs 16 inches on centers, including jack studs above and below openings, except as otherwise shown.
- E. Anchor light-gage screw-type partition studs to runner tracks by screw. Screw end studs to both tracks at both flanges.
- F. Install minimum of three studs at partition corners and intersections, spaced as recommended by stud manufacturer for the application indicated.
- G. Install horizontal stud system stiffeners in continuous runs at the spacing indicated. Weld or wire-tie at each stud intersection.
 - 1. Space curtain wall stiffeners 4.5 feet on centers, and install double stiffeners, one each face, where unsupported wall height exceeds 18 feet.
 - 2. Space partition stiffeners 4.5 feet on centers in light-gage screw-type stud systems, which are to receive gypsum lath and plaster.
- H. Provide additional studs at each jamb of openings more than two feet wide, and secure jamb studs to frames of openings and to runner tracks above and below openings in manner indicated. Screw to frame anchors or directly to frames, or wire-tie or weld, if not otherwise indicated.

1. Install two studs at each jamb, except as otherwise shown.
 2. Install stud system stiffeners not more than six inches above and six inches below each opening, and extend two regular stud spaces beyond opening both ways.
- I. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
1. Firestop Track: Where shown or indicated, provide to maintain continuity of fire-resistance-rated assembly indicated.
- J. Direct Furring:
1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced two feet on centers.

3.6 METAL FURRING

- A. Space furring members: 16 inches on centers, unless otherwise shown or indicated.
- B. Z-Furring Members:
1. Erect insulation, specified in Section 07 21 05, Building Insulation, vertically and hold in place with Z-furring members spaced two feet on centers.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced two feet on centers.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

3.7 AUXILIARY STEEL STUD SYSTEM COMPONENTS

- A. Anchor each flange of auxiliary non-structural metal framing system components to plaster base eight inches on centers.
- B. Miter or cope accessory corners, and install with tight joints accurately aligned.
- C. Install prefabricated control joints of one-piece design, where shown or indicated as control joint.
- D. Install prefabricated expansion joints of two-piece design, where shown or indicated as expansion joint, 1/4-inch joint width for interior Work, 3/8-inch for exterior Work.

3.8 FIELD QUALITY CONTROL

- A. Before installing non-structural metal framing ceilings, inspect deck accompanied by ENGINEER and prepare written report of deficiencies. Do not proceed with installation of non-structural metal framing until defective Work is corrected.
 - 1. Notify ENGINEER at least ten days in advance of date and time when Work, or part of Work, will be ready for above ceiling observation.
 - 2. Before notifying ENGINEER, complete the following in areas to receive non-load-bearing steel framing ceilings:
 - a. Installation of insulation, and successful testing of piping conveying fluids.
 - b. Installation of ventilation duct system.
 - c. Installation of air distribution devices.
- B. Special Inspections: Coordinate with the Coordinating Special Inspector. Refer to Section 01 45 33.00, Code-Required Special Inspections, for detailed requirements.

3.9 ADJUSTING AND REPAIR

- A. Cut, repair, and align non-structural metal framing Work as required and as necessary to accommodate other work. Repair bent and dented members. Repair or replace the Work as necessary to comply with specified tolerances.

3.10 CLEANING

- A. Remove temporary covering and other provisions made to minimize debris on other work. Repair surfaces that have been stained, marred or otherwise damaged during non-structural metal framing Work. When Work is completed, remove unused materials, containers, and equipment and debris.

3.11 RELATED WORK

- A. Lath and Cement Plaster Installation: Refer to Section 09 24 00, Portland Cement Plastering.
- B. Gypsum Board Installation: Refer to Section 09 21 16, Gypsum Board Assemblies.

3.12 PROTECTION OF EXECUTED WORK

- A. Provide adequate precautions for protecting non-structural metal framing Work from deterioration and damage during remainder of construction.

+ + END OF SECTION + +

SECTION 09 24 00

PORTLAND CEMENT PLASTERING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install all cement plaster. The Work also includes:
 - a. Providing openings in cement plaster to accommodate the Work under this and other Sections, and building into cement plaster items such as sleeves, anchorage devices, inserts, and all other items to be embedded in cement plaster for which placement is not specifically provided under other Sections.
2. Extent of cement plaster is shown.
3. Types of products required include the following:
 - a. Interior portland cement plaster.
 - c. Factory-prepared finish coat.
 - d. Acrylic-based, factory-prepared finish coat.
 - e. Metal lath.
 - f. Accessories.
 - g. Miscellaneous materials.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before cement plaster Work.
2. Coordinate furnishing and installing products for maintaining fire-resistance-rating of cement plaster at perimeters and penetrations where built-in and recessed items and transitions with other building components occur in the Work.

C. Related Sections:

1. Section 06 10 53, Miscellaneous Rough Carpentry.
2. Section 07 92 00, Joint Sealants.
3. Section 09 22 16, Non-Structural Metal Framing.
4. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ACI 306.1, Specification for Cold Weather Concreting.
2. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM C11, Terminology Relating to Cement and Related Building Materials and Systems.
5. ASTM C25, Test Methods for Chemical Analysis of Limestone, Quick-Lime and Hydrated Lime.
6. ASTM C91, Specification for Masonry Cement.
7. ASTM C150, Specification for Portland Cement.
8. ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
9. ASTM C206, Specification for Finishing Hydrated Lime.
10. ASTM C595, Specification for Blended Hydraulic Cements.
11. ASTM C665, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
12. ASTM C834, Specification for Latex Sealants.
13. ASTM C841, Specification for Installation of Interior Lathing and Furring.
14. ASTM C847, Specification for Metal Lath.
15. ASTM C897, Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters.
16. ASTM C919, Practice for Use of Sealants in Acoustical Applications.
17. ASTM C926, Specification for Application of Portland Cement-Based Plaster.
18. ASTM C932, Specification for Surface-Applied Bonding Compounds for Exterior Plastering.
19. ASTM C933, Specification for Welded Wire Lath.
20. ASTM C1032, Specification for Woven Wire Plaster Base.
21. ASTM C1063, Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement Based Plaster.
22. ASTM C1328, Specification for Plastic (Stucco) Cement
23. ASTM D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
24. ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
25. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
26. FS UU-B-790, Building Paper, Vegetable FiberⓈKraft, Waterproofed, Water Repellant and Fire Resistant)
27. ML/SFA 920, Specification for Metal Lathing and Furring.
28. PCA, Portland Cement Plaster/Stucco Manual.
29. UL, Fire Resistance Directory.
30. USGBC, LEED-NC, LEED Reference Guide for New Construction and Major Renovation.

1.3 TERMINOLOGY

A. Terminology used in this Section is in accordance with ASTM C11.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Provide cement plaster and auxiliary products and accessories manufactured by firms specializing in producing types of products specified, in compliance with the Contract Documents.
 - b. Provide cement plaster and auxiliary products and accessories manufactured by firms who are members of ML/SFA and AWCI, and participate in their certification programs.
2. Installer:
 - a. Engage a single installer regularly performing cement plaster installation, and with documented skill and successful experience in installing types of materials required; and who employs only tradesmen who are trained, skilled, and have successful experience in installing types of materials specified.
 - b. Submit name and qualifications with the following information for at least three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for each project.
 - 2) Approximate contract cost of cement plastering.
 - 3) Quantity (area) installed.

B. Component Supply and Compatibility:

1. Provide cement plaster products from manufacturer who provides test certificates for published fire, sound, and structural data covering systems designed and constructed according to its published specifications.
2. Obtain all cement plaster products from single source and single manufacturer.

C. Regulatory Requirements:

1. Where fire resistance classification (four-hour, three-hour, and similar designations) is shown or scheduled which includes cement plaster, provide components complying with applicable requirements for materials and installation established by UL and authorities having jurisdiction.
2. Provide cement plaster having same aggregate as specified for similar non-rated Work, unless specified aggregate has not been tested and approved by UL for the required rating.
3. UL Compliance: Comply with UL Fire Resistance Directory for applicable fire-test-response characteristics. Use finish-coat plaster originally tested and rated with base-coat plaster.
4. Use finish-coat plaster originally tested and rated with base-coat plaster.
5. Vibration, Seismic and Wind Controls: The Work shall conform to seismic, vibration and wind requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls. Support system shall conform to Laws and Regulations,

- including building code referred to in Section 01 42 00, References. Refer to Section 01 45 33, Code-Required Special Inspections and Procedures.
6. Comply with 40 CFR 59, Subpart D, National Volatile Organic Compound Emission Standards for Architectural Coatings.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Product Data:
 - a. Manufacturer's product data, specifications, and performance data for each item and each system specified.
 - b. Copies of test reports verifying compliance with physical properties, quality assurance performance requirements, and compatibility testing of primer specified in Section 09 91 00, Painting.
 - c. Include reports and other data as may be required to show compliance with the Contract Documents.
- B. Informational Submittals: Submit the following:
 1. Certificates.
 - a. Certificates stating that materials meet or exceed requirements of the Contract Documents and stating that materials have been provided as specified to meet fire-resistance-ratings, thickness requirements, and application requirements.
 2. Supplier Instructions:
 - a. Manufacturer's mixing and installation instructions for each material specified
 3. Site Quality Control Submittals:
 - a. Results of specified inspections and observations.
 - b. Refer to Section 01 45 33, Code-Required Special Inspections and Procedures for reporting requirements.
 4. Qualifications Statements:
 - a. Manufacturer, when required by ENGINEER.
 - b. Installer.

1.6 PROJECT CONDITIONS

- A. Environmental Requirements:
 1. Comply with applicable requirements of ASTM C926.
 2. Temporary Heat: Provide temporary heating and protection as required to protect each coat of cement plaster from freezing for not less than 24 hours after application.
 - a. Exterior Cement Plaster Work: Protect cement plaster against cold when ambient temperature is less than 40 degrees F. Heat materials and provide temporary protection and heating as required by ACI 306.1.

- b. Interior Cement Plaster Work: Maintain not less than 50 degrees F temperature in areas to be plastered for not less than forty-eight hours before, during, and after application.
3. Distribute heat uniformly in areas to be plastered and provide deflection or protective screens as required to prevent concentration of heat on cement plaster near heat source.
4. Supplemental heat and power sources, as may be required should CONTRACTOR wish to continue cement plaster Work in cold weather, are not available at the Site. Provision of supplemental heat, including fuel, equipment, operating and maintenance personnel, and power sources, is responsibility of CONTRACTOR.
5. Warm Weather Requirements: Protect cement plaster against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial. Apply and cure cement plaster as required by climatic and Site conditions to prevent dry-out during cure period. Provide suitable coverings, moist-curing, barriers to deflect sunlight and wind, or combinations of these, as required.
6. Ventilation Requirements: Provide natural or mechanical means of ventilation to remove water in excess of that required for hydrating cement plaster after application. Begin ventilation immediately after plaster is applied and continue until plaster sets.
 - a. If glass is not in place and areas to be plastered are subjected to hot dry winds or will be subjected to temperature differentials of 20 degrees F or more, cover openings with polyethylene film arranged to allow proper ventilation without excessive, non-uniform curing or temperature variations.
 - b. Avoid conditions that result in cement plaster drying too rapidly. Provide moisture-cure and maintain relative humidity levels, as recommended by manufacturer, appropriate for prevailing ambient temperatures that will produce normal curing conditions.

1.7 SEQUENCING

- A. In general, complete plastering prior to installing adjoining tile Work, marble, acoustical materials, and similar finishes.
- B. Finish Coat:
 1. Delay application of interior finish coat plastering until cementitious bases and similar adjoining Work is complete.
 2. Delay application of exterior finish coat plastering until adjoining Work is complete, where possible.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Performance Criteria:
1. General:
 - a. Standards: Comply with ASTM C926 and PCA Portland Cement Plaster/Stucco Manual for all Work, except when more stringent requirements in the Contract Documents, or when more stringent measures are required by authorities having jurisdiction.
 2. Vibration and Seismic Controls: Support system shall conform to Laws and Regulations including building code referred to in Section 01 42 00, References. Refer to Section 01 45 33, Code-Required Special Inspections and Procedures, and Section 40 05 96, Vibration, Seismic, and Wind Controls.
 3. Fire-Resistance-Rated Cement Plaster Systems:
 - a. Where fire resistance classification (four-hour, three-hour, and similar designations) is shown or scheduled that includes cement plaster systems, provide system components coordinated and complying with the applicable requirements of materials and installation established by UL and authorities having jurisdiction.
 - b. Provide cement plaster having same aggregate specified for similar non-rated cement plaster systems, unless specified aggregate has not been tested and approved by UL for required rating.
 - c. Fire-Test Response Characteristics: Where fire-resistance rated cement plaster systems are shown or indicated, provide materials and construction identical to those assemblies tested for fire resistance in compliance with ASTM E119 by independent testing and inspection agency acceptable to authorities having jurisdiction.

2.2 MANUFACTURERS

- A. Metal Lath Components: Provide products of one of the following:
1. Dietrich Metal Framing, Inc.
 2. Marino\WARE, Division of Ware Industries, Inc.
 3. Or equal.
- B. Plastering Materials: Products and manufactures for each material are specified in this Section in the Articles on plastering materials:

2.3 METAL FRAMING AND FURRING MATERIALS

- A. Refer to Section 09 22 16, Non-Structural Metal Framing.

2.4 METAL LATH MATERIALS

- A. General: Unless otherwise specified, comply with ML/SFA 920 for selection of metal lath for each application specified.
1. Product Standard: Comply with ASTM C847.

2. Backing: Where lath is indicated to have backing, and where backing is required for machine application of plaster, provide lath with factory applied backing of moisture resistant paper or polyethylene film.
3. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.
4. Metal Lath Components: Hot-dipped galvanized finish; ASTM A653, G90, for 18-gage (0.0451-inch, minimum) and lighter formed metal products, ASTM A123, galvanized after fabrication, for 16-gage (0.0566-inches, minimum) and heavier products.
5. Interior Diamond Mesh Lath: 2.5 pounds per square yard standard mesh.
6. Self-Furring Diamond Mesh Lath: 2.5 pounds per square yard standard mesh sheet with 1/4-inch deformations.
7. Flat Rib Lath: 2.75 pounds per square yard, 1/8-inch rib depth.
8. Flat Rib Lath: 3.4 pounds per square yard, 1/8-inch rib depth.
9. Rib Lath, 3/8-inch: 3.4 pounds per square yard, 3/8-inch rib depth.
10. Rib Lath, 3/8-inch: 4.0 pounds per square yard, 3/8-inch rib depth.
11. Sheet Lath: 4.75 pounds per square yard perforated and rigidized.
12. Welded-Wire Lath: ASTM C933: self-furring.
 - a. Weight: 1.95 lb/sq. yd.
13. Woven-Wire Lath: ASTM C1032: self-furring, with stiffener wire backing.
 - a. Weight: 1.4 lb/sq. yd.
14. Paper Backing: FS UU-B-790, Type I, Grade A, 6.0 lb/100 sq. ft.
 - a. Provide paper-backed lath unless otherwise indicated.

2.5 METAL LATH ACCESSORIES

- A. General: Comply with ASTM C1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Plastering Accessories: Hot-dipped galvanized finish; ASTM A653, G60, for auxiliary components including perforated flange corner beads, casing beads, caps, screeds, moldings, single-vee perforated flange control joints, two-piece perforated flange expansion joints, and similar units as indicated or required for exterior use and for use in high humidity areas, except where fully concealed in plaster.
- C. Accessories:
 1. Cornerite: Fabricated from expanded-metal lath.
 2. Striplath: Fabricated from expanded-metal lath.
 3. Cornerbeads: Fabricated from galvanized steel.
 - a. Small nose cornerbead with expanded flanges; use unless otherwise indicated.
 - b. Small nose cornerbead with perforated flanges; use on curved corners.
 - c. Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.

- d. Bull nose cornerbead, radius 3/4-inch minimum, with expanded flanges; use at locations indicated on Drawings.
- 4. Casing Beads: Fabricated from galvanized steel: square-edged style: with expanded flanges.
- 5. Control Joints: Fabricated from galvanized steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
- 6. Expansion Joints: Fabricated from galvanized steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
- 7. Two-Piece Expansion Joints: Fabricated from galvanized steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4- to 5/8-inch wide; with perforated flanges.

2.6 CEMENT PLASTERING MATERIALS

- A. General: Except as otherwise shown or indicated, provide standard products recommended by the manufacturers specified, for the application shown or indicated. Provide either neat or factory-mixed materials.
- B. Base-Coat Cement: Provide one of the following cements, or mixtures thereof, where recommended by cement manufacturer.
 - 1. Portland Cement:
 - a. ASTM C150, Type I.
 - b. Provide non-staining, Portland cement that will attain compressive strength of not less than 2,800 psi at three days and 4,000 psi at seven days.
 - 3. Blended Hydraulic Cement: ASTM C595, Types IP, or IP-A.
 - 4. Plastic Cement: Portland cement complying with ASTM C1328.
- C. Base-Coat Lime:
 - 1. ASTM C206, Type S special hydrated lime for finishing purposes.
- D. Base Coat Aggregate: Sand, ASTM C897.
- E. Acrylic-Based, Factory-Prepared Finish-Coat: Provide factory-mixed formulation of acrylic emulsion, colorfast mineral oxide pigments, and fine aggregates specifically recommended by acrylic-based finish manufacturer for use over portland-cement plaster base-coats. Provide complete selection of manufacturer's standard colors for final selection by ENGINEER.
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Dryvit TAFS by Dryvit Systems Inc.
 - b. Stucco Tex by Sono Wall, BASF Wall Systems Inc.
 - c. Or equal.
 - 2. Color and Texture: Texture to match adjacent existing plaster texture. Color to be white for topcoating with paint.

2.7 MISCELLANEOUS PLASTER MATERIALS

- A. Base-Coat Fiber: Alkaline-resistant glass polypropylene fibers, 1/2-inch long, free of contaminants and manufactured for use in portland cement plaster.
- B. Bonding Agent: ASTM C932.
- C. Acid-Etching Solution: Muriatic acid, ten percent solution of commercial hydrochloric acid, mixed one part to not less than six or more than ten parts of water.
- D. Dash Coat Material: Two parts cement to three parts fine sand, mixed with water to a paste consistency.
- E. Isolation Strip at Exterior Walls:
 - 1. Asphalt-saturated Organic Felt: ASTM D226, Type I (No. 15 asphalt felt) unperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.
- F. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant, with a VOC content of 50 g/L or less when calculated. According to 40 CFR 59, Subpart D (EPA Method 24),] complying with ASTM C834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.
 - 1. Products and Manufacturers: provide one of the following:
 - a. AC-20 + Silicone by Pecora Corporation.
 - b. Tremflex 834 by Tremco, Inc.
 - c. Or Equal
- G. Calking and Sealants: Refer to Section 07 92 00, Joint Sealants.
- H. Water: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath or accessories.

2.8 CEMENT PLASTER MIXES AND COMPOSITIONS

- A. General: Comply with ASTM C926 for base- and finish-coat mixes applicable to plaster bases, materials, and other requirements specified.
- B. Base-Coat Mixes and Compositions: Proportion materials for respective base-coats in parts by volume per sum of cementitious materials for aggregates to comply with requirements for each method of application and plaster base indicated. Adjust mix proportions within limits specified to attain workability.

- C. Fiber Content: Add fiber to mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's approved written instructions, but do not exceed one pound per cubic foot of cementitious materials. Reduce aggregate quantities accordingly to maintain workability.
- D. Three-Coat Cement Plaster Over Metal Lath: Provide base-coat proportions as follows:
 - 1. Scratch-Coat: One part plastic cement, one part portland cement, 2.5 to four parts aggregate.
 - 2. Brown-Coat: One part plastic cement, one part portland cement, three to five parts aggregate.
- E. Acrylic-Based Finish Coats: Add water only; comply with manufacturer's written instructions.
- F. Bonding Additive: Proportion and mix in accordance with additive manufacturer's instructions.

2.9 CEMENT PLASTER MIXING

- A. Mechanically mix cementitious and aggregate materials for cement plasters to comply with applicable referenced application standards and with approved recommendations of cement plaster manufacturer.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine surfaces to receive cement plaster, including grounds and other auxiliary system components that act as grounds or screeds, and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with cement plaster Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Clean cement plaster bases, and substrates for direct application of cement plaster, removing loose material and substances that may impair cement plaster system performance.
- B. Provide temporary grounds and screeds as necessary to ensure accurate rodding of cement plaster to true surfaces; coordinate with scratch-coat Work.
 - 1. Refer to Section 06 10 53, Miscellaneous Rough Carpentry, for the installation of permanent wood grounds.

3.3 INSTALLATION, GENERAL

- A. Fire-Resistance-Rated Assemblies: Provide components according to requirements for design designations indicated in the Contract Documents from listing organization and UL Fire Resistance Directory.
- B. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
- C. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.
- D. Allowable Tolerances:
 - 1. For flat surfaces, do not exceed 1/8-inch in ten feet from a true plane in finished plaster surfaces, as measured by ten-foot straightedge placed at any location on plastered surfaces.
 - 2. Where brown-coat plaster is specified to receive adhesively applied finish, comply with specified tolerances for finish-coat plastering.

3.4 INSTALLATION OF METAL FRAMING AND FURRING

- A. Refer to Section 09 22 16, Non-Structural Metal Framing.

3.5 INSTALLATION OF METAL LATH

- A. General:
 - 1. Comply with manufacturer's installation instructions and recommendations. If a discrepancy exists with the Contract Documents, request interpretation from ENGINEER.
 - 2. Comply with ML/SFA 920 and ASTM C1063, except where otherwise shown or indicated.
 - 3. Install metal lath by wire tying supports or substrate in the manner shown and in accordance with ASTM C841.
 - a. Nail self-furring diamond mesh directly to masonry and concrete substrates where shown for direct plaster application.
 - 4. Install with long dimension of lath across the supports.
 - 5. Lap sides of wire mesh not less than 1/2-inch. Lap ends not less than one-inch. Stagger end laps, wire ties, side laps at intervals not exceeding nine inches, lace end laps.
 - 6. At external corners, cut and butt lath and provide continuous corner reinforcing.
 - 7. Provide corner reinforcing at openings, at ends of arches, and at all other exposed corners.
 - 8. Schedules: Comply with Table 09 24 00-A of this Section.
- B. Installation of Auxiliary Metal Lath Components:
 - 1. Comply with ASTM C1063, except where otherwise shown or indicated.

2. Anchor each flange of auxiliary metal lath system components to plaster base eight inches on centers.
3. Miter or cope accessory corners, and install with tight joints accurately aligned.
4. Provide metal corner beads at external corners.
5. Provide casing beads at terminations of plaster Work, except where plaster is shown to pass through other Work and be concealed by other materials, and except where special screeds, bases or frames act as casing beads including interior metal door frames.
 - a. For exterior Work, set casing beads 1/4-inch from abutting frames and other Work, for application of sealant.
 - b. Where plaster abuts concrete, set casing bead 1/4-inch from concrete.
 - c. Where interior plaster abuts exterior masonry, apply waterproof plastic adhesive tape on concealed face of bead.
 - d. Where interior plaster abuts exterior door frames and similar Work in exterior walls, provide resilient edged-casing beads.
 - e. At control joints and expansion joints set pair of casing beads back-to-back with metal strip behind anchored to only one side of joint. At expansion joints, space beads 1/4-inch apart for interior Work, 3/8-inch apart for exterior Work.

3.6 INSTALLATION, CONTROL AND EXPANSION JOINTS

- A. In accordance with ASTM C1063 located control joints as follows:
 1. Delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 square feet.
 - b. Horizontal and Other nonvertical Surfaces: 100 square feet.
 - c. At distances between control joints of not more than 18 feet on centers.
 - d. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2 1/2:1.
 - e. Where control joints occur in surface of construction directly behind plaster.
 - f. Where plastered ceiling framing or furring changes direction.
 - g. Where plasterwork areas change dimensions, to delineate rectangular shaped areas (panels) to relieve stress that occurs at corner formed by dimension change.

3.7 INSTALLATION OF CEMENT PLASTER

- A. General:
 1. Standards: Except as otherwise shown or indicated, comply with ASTM C926.
 2. Provide moisture-cure plaster base- and finish-coats to comply with ASTM C926, including Annex A2, Design Considerations, written instructions for time between coats and curing.
 3. Do not use materials that are frozen, caked or lumpy, or that are dirty or contaminated by foreign materials.

4. Use only potable water, free from impurities that might impair the cement plaster Work. Do not use water that has been used to clean tools.
5. Do not use excessive water in mixing and applying cement plaster materials.
6. Grout hollow metal frames, bases and similar Work occurring in plastered areas of interior Work, using base-coat materials. Where necessary for grouting access, grout prior to lathing.
 - a. Grout frames and bases solidly and continuously.
7. Sequence plastering applications in accordance with Article 1.7 of this Section.
8. Plaster flush with metal frames and other built-in metal items or accessories, that act as plaster ground, unless specifically shown otherwise. Where interior cement plaster is not terminated at metal by casing beads, cut base coat free from metal before cement plaster sets and groove finish coat at junctures with metal.
9. Corners: Make internal corners and angles square; finish external corners flush with corner beads on interior Work, and square and true with stucco faces on exterior Work.
10. Schedules: Comply with Table 09 24 00-A of this Section.

B. Cement Plaster Applications:

1. Provide three-coat cement plaster over metal lathed and metal reinforced substrates (scratch, brown, and finish coats); and apply two-coat (base and finish coats) over direct-plastered concrete and concrete unit masonry substrates. Do not apply three-coat cement plaster on horizontal masonry substrates.
 - a. Back-plaster exterior metal lath and plaster where shown and where lath is neither over a solid base nor fabricated with integral paper backing. Provide base-coat cement plaster to thickness of 1/2-inch from back face of lath.
2. Cement Plaster Thicknesses: Provide base-coat 3/4-inches thick and finish-coat 1/8-inches thick, for total cement plaster thickness of 7/8-inches, except as follows:
 - a. On metal reinforcing, provide minimum scratch-coat thickness of 1/2-inch. On backings that are not solid, apply a minimum thickness of 3/8-inch.
 - b. Provide finish-coat cement plaster not less than 1/8-inch thick, and increase thickness as required to achieve required texture, pattern, and embedment of exposed aggregate or other finish requirements as specified.

C. Finish-Coat Texture/Pattern - Match existing plaster ceiling texture using appropriate methods and tools:

1. Sand-Float Plaster Finish: Float finish-coat application to uniform sand-float texture. Match existing plaster ceiling, or, if none, provide standard sand-float texture.
2. Dash Plaster Finish: Where shown, dash finish-coat application in two-coats over base-coat by machine application, to an even and uniform dash finish

matching mock-up or, if none, provide standard medium textured dash finish.

3. Trowel-Textured Finish: Provide finish-coat with hand-trowel-textured finish as established by approved Sample or as approved on mock-up.

D. Curing Cement Plaster:

1. Install each coat of cement plaster within 20 to 30 hours after installing preceding coat, and protect each base-coat from excessive dry-out during the Work. Protect finish-coat from dry-out for 20 to 24 hours after placement, or until curing operation will not damage surface, and moisture-cure until not less than 48 hours after time of placement. Moisture-cure by maintaining in moist condition, by frequent fog spraying with water and by protecting from fast dry-out with covering of polyethylene film or similar enclosure.
2. Refer to Section 09 91 00, Painting, for application of paint finish and coatings on cement plaster.

3.8 FIELD QUALITY CONTROL

- A. Before installing cement plaster ceilings, inspect ceiling support framing accompanied by ENGINEER and submit written report of deficiencies. Do not proceed with installing cement plaster on ceiling support framing until deficiencies are corrected.
 1. Notify ENGINEER ten days in advance of the date and time when Work, or part of Work, will be ready for above ceiling observation.
 2. Before notifying ENGINEER, complete the following in areas to receive cement board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation of insulation, and successful testing of piping conveying fluids and automatic fire suppression system.
 - c. Installation of ventilation duct system.
 - d. Installation of air distribution devices.
 - e. Installation of ceiling support framing.
- B. Special Inspections: Coordinate with the Coordinating Special Inspector. Refer to Section 01 45 33, Code-Required Special Inspections and Procedures, for requirements.

3.9 REPAIR

- A. Cut, patch, repair, and point-up cement plaster as required and as necessary to accommodate other Work. Repair cracks and indented surfaces. Point-up finish plaster surfaces around items built into or penetrating plaster surfaces. Repair or replace the Work to eliminate blisters, buckles, check cracking, dry-outs, efflorescence, excessive pinholes, and similar imperfections. Repair or replace defective Work as necessary to comply with specified tolerances and required visual effects.

3.10 CLEANING AND PROTECTION

- A. Remove temporary covering and other provisions made to minimize spattering of cement plaster on other work. Promptly remove cement plaster from door frames, windows, and other surfaces, that are not to be plastered. Repair surfaces that have been stained, marred, or otherwise damaged during cement plastering Work. When cement-plastering Work is complete, remove unused materials, containers, and equipment and cement plaster debris.
- B. Protect cement plaster from deterioration and damage during remainder of construction.

3.11 SCHEDULES

- A. The schedules listed below are part of this Section:
 - 1. Table 09 24 00-A: Furring and Plaster Systems

TABLE 09 24 00-A: FURRING AND PLASTER SYSTEMS

Location	Lath	Coats	Base Coat	Finish Coat	Finish	Thickness	Facility
Interior Stud Ceilings	Match existing	Three	Ready-mixed	Ready-mixed	Match existing	7/8-inch	Beardsley PS
Notes:							

+ + END OF SECTION + +

++NO TEXT ON THIS PAGE++

SECTION 09 30 13

CERAMIC TILE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified and required to furnish and install all ceramic tile. The Work also includes:
 - a. Providing openings in ceramic tile to accommodate the Work under this and other Sections, and building into the ceramic tile all items to be embedded in or penetrate ceramic tile Work.
2. Extent of ceramic tile Work is shown or indicated.
3. Types of products required include:
 - a. Glazed ceramic wall tile.
 - b. Recycled porcelain glazed floor tile.
 - c. Latex-portland cement setting bed mortar.
 - d. Latex-portland cement bond coat mortar.
 - e. Latex-portland cement sanded grout.
 - f. Custom marble thresholds.
 - g. Auxiliary materials, additives, accessories, and trim.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ceramic tile Work.
2. Comply with ANSI American National Standard Specifications for the Installation of Ceramic Tile for related trade coordination.
3. Coordinate substrate finishing and curing techniques for type of ceramic tile installation required.
4. Coordinate substrate finishing with other Sections and coordinate installation requirements of those Sections with the Work of this Section.
5. Coordinate final locations of structural expansion joints, control joints, cold joints, and saw-cut control joints so that such joints do not interrupt ceramic tile pattern shown.

C. Related Sections:

1. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI, American National Standard Specifications for the Installation of Ceramic Tile.

2. ANSI A10.20, Safety Requirements for Ceramic Tile, Terrazzo and Marble Work.
3. ANSI A108.1, Installation of Ceramic Tile.
4. ANSI A108.5, Ceramic Tile.
5. ANSI A108.10, Installation of Grout in Tilework.
6. ANSI A118.4, Latex-Portland Cement Mortar.
7. ANSI A118.7, Polymer Modified Cement Grouts for Tile Installation.
8. ANSI A137.1, American National Standards Specification for Ceramic Tile.
9. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
10. ASTM A185, Specification for Steel Welded Wire Reinforcement, Plain for Concrete.
11. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
12. ASTM C144, Specification for Aggregate for Masonry Mortar.
13. ASTM C150, Specification for Portland Cement.
14. ASTM C171, Specification for Sheet Materials for Curing Concrete.
15. ASTM C241, Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic.
16. ASTM C373, Test Method for Water Absorption, Bulk Density, Apparent Porosity and Apparent Specific Gravity of Fired Whiteware Products.
17. ASTM C424, Test Method for Craze Resistance of Fired Glazed Whitewares by Autoclave Treatment.
18. ASTM C482, Test Method for Bond Strength of Ceramic Tile to Portland Cement Paste.
19. ASTM C485, Test Method for Measuring Warpage of Ceramic Tile.
20. ASTM C499, Test Method for Facial Dimensions and Thickness of Flat, Rectangular Ceramic Wall and Floor Tile.
21. ASTM C501, Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
22. ASTM C503, Specification for Marble Dimension Stone (Exterior).
23. ASTM C627, Test Method for Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester.
24. ASTM C648, Test Method for Breaking Strength of Ceramic Tile.
25. ASTM C650, Test Method for Resistance of Ceramic Tile to Chemical Substances.
26. ASTM C847, Specification for Metal Lath.
27. ASTM C1026, Test Method for Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling.
28. ASTM C1028, Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
29. ASTM C87, Test Method for Melting Point of Petroleum Wax (Cooling Curve).
30. ASTM D2240, Test Method for Rubber Property - Durometer Hardness.
31. TCNA, Handbook for Ceramic Tile Installation.

32. USGBC LEED-NC, Reference Guide For New Construction and Major Renovation.

1.3 TERMINOLOGY

- A. Terminology used in this Section is in accordance with:
1. Terminology, explanations, requirements, and notes in the Foreword to ANSI Standard Specifications for the Installation of Ceramic Tile.
 2. All terms in ANSI A137.1.
- B. The following words or terms are not defined but, when used in this Section, have the following meaning:
1. “Ceramic tile” is a ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay, or mixture of clay and other ceramic materials, called the body of the tile, having either a glazed or unglazed face and fired above red heat in the course of manufacture to temperature sufficiently high to produce specific physical properties and characteristic specified.

1.4 QUALITY ASSURANCE

- A. Qualifications:
1. Manufacturer:
 - a. Provide ceramic tile and auxiliary products and accessories manufactured by firms specializing in producing types of products specified, in compliance with reference standards used in this Section.
 - b. Provide ceramic tile and auxiliary products and accessories manufactured by firms that are members of TCNA and participate in TCNA certification programs.
 2. Installer:
 - a. Engage a single installer regularly performing ceramic tile installation, and with documented skill and successful experience installing types of materials required; and that employs only tradesmen who are trained, skilled, and have successful experience installing types of materials specified.
 - b. Submit installer name and qualifications, and the following information for at least three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.
 - 2) Approximate contract cost of the ceramic tile.
 - 3) Quantity (area) installed.
- B. Component Supply and Compatibility:
1. Provide each type of ceramic tile from only one manufacturer.
 2. Provide ceramic tile from source with adequate resources to provide ceramic tile of same color, grade, finish, type, and variety, and from same production

- run, and of consistent quality, appearance, and physical properties, for each contiguous area, without delaying the Work.
3. Provide modified cement mortars, bonding adhesives, and grouts of generic type specified, but of brand acceptable to or recommended by ceramic tile manufacturer.
 4. Obtain all ceramic tile setting and grouting products from one manufacturer.
- C. Regulatory Requirements:
1. Comply with Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to 28 CFR 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG).
- D. Mock-Ups:
1. Prior to installing ceramic tile and accessories, but after ENGINEER's approval of Samples and Action Submittals, provide four-foot square Sample of each type of ceramic tile floor and wall system in areas selected by ENGINEER to show representative installation of the Work.
 2. Obtain ENGINEER's approval of colors, patterns, textures, and tolerances before starting ceramic tile Work. Retain and protect mock-ups during construction as a standard for judging completed ceramic tile Work. Do not alter, move, or destroy mock-up panels until corresponding ceramic tile Work is acceptably completed.
 3. Approved mock-ups may become part of the Work if approved mock-ups remain undamaged and undeteriorated at Substantial Completion.
 4. Remove and replace with new material ceramic tile Work that does not conform to the standard approved on mock-ups.
 5. Do not commence ceramic tile installation without obtaining ENGINEER's approval of associated mock-up.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Completely-dimensioned and detailed drawings for ceramic tile Work utilizing modular planning to minimize cutting. Show ceramic tile pattern and recommended location of control joints and expansion joints in finished ceramic tile Work.
 - b. Show all ceramic tiles including location of each type, color, and pattern. Show coordinated details for construction systems adjacent to ceramic tile that may affect ceramic tile pattern. Submit large-scale details for interrelated thresholds, floor drains, coves, equipment pads, trench drains, shower bases, horizontal pipe chases, columns, and similar items that will interrupt or be coordinated with ceramic tile system, based on dimensions obtained through Site measurements.
 2. Product Data:
 - a. Copies of manufacturer's specifications and literature for all required materials. Include manufacturer's published data, indicating that each

material complies with the Contract Documents and is suitable for the application shown.

- b. Test Reports: Submit certified laboratory test reports, for products identical to those to be provided for the Project, indicating conformance with the requirements specified.
- 3. Samples: Sample submittals will be reviewed by ENGINEER for color, texture and pattern only. Compliance with all other requirements is the responsibility of CONTRACTOR. Submit the following:
 - a. Ceramic tile mounted on 12-inch square hardwood boards showing color, type, and class of each ceramic tile required.
 - b. Manufacturer's full selection of standard and custom colored grout. Provide actual Samples of each grout material color, applied between metal or plastic flanges, for selection by ENGINEER.
 - c. Marble thresholds with color, profile, and finish specified, full width and 12 inches long.
 - d. Mock-up(s).

B. Informational Submittals: Submit the following:

- 1. Certificates.
 - a. Master Grade Master Grade Certificate and Tile Contractor's Certificate signed by manufacturer and installer, for each type of ceramic tile in compliance with procedures established by ANSI A137.1 for ceramic tile.
 - b. Certificate stating that products licensed by the TCNA have been supplied, where applicable.
 - c. Certify that tiles from the same production run are available in sufficient quantity for the Work.
 - d. Installer certification.
 - e. Certify that setting bed mortars and grouts have been stored off the ground in factory-sealed containers and bags, and in areas maintained within humidity limitations recommended by product manufacturer.
 - f. Certify that setting bed mortar and grout materials were manufactured within 12 months of installation and have not and will not be subjected to freezing temperatures.
- 2. Supplier Instructions:
 - a. Copies of TCNA Handbook for Ceramic Tile Installation showing proposed installation system, materials and details for each area of the Work.
- 3. Qualifications Statements:
 - a. Manufacturer, when required by ENGINEER.
 - b. Installer.

C. Closeout Submittals:

- 1. Maintenance Data: Submit in accordance with 01 78 23, Operations and Maintenance Data, manufacturer's instructions for recommended maintenance practices for each type of ceramic tile, including the following:
 - a. Product name and number.

- b. Name, address and telephone number of manufacturer and local distributor.
- c. Detailed procedures for routine maintenance and cleaning.
- d. Detailed procedures for light repairs such as dents, scratches and staining.

D. Maintenance Material Submittals:

- 1. Extra Stock Materials: At time of completing ceramic tile installation, deliver stock of extra material and store in accordance with Section 01 78 43, Spare Parts and Extra Materials. Furnish full-size units, packaged with protective covering for storage, and identified with labels.
 - a. Ceramic Tile: Furnish quantity of ceramic tile equal to two percent of quantity installed, or at least one full package.
 - b. Do not furnish partial packages of materials. Round-up quantities to furnish only complete, unopened and undamaged packages; with legible labels accurately representing contents of package indicating compliance with approved Samples and submittals, and matching materials actually installed.
 - c. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials used in the Work, with calculations establishing quantity of extra materials to be furnished.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements of applicable reference standards used in this Section, Section 01 65 00, Product Delivery Requirements, Section 01 66 00, Product Storage and Handling Requirements, and the following.
 - 1. Deliver ceramic tile bearing manufacturer's name with standard grade labels complying with ANSI A137.1.
 - 2. Tile shall be accompanied by certificate and shipping receipt from manufacturer stating grade of tile, number and kinds of containers and shipping identification.
 - 3. Include identification and formula numbers on containers of setting and grouting materials produced under TCNA license.
 - 4. Failure to comply with requirements of this Article shall be sufficient cause for ENGINEER'S rejection of the material in question. Remove unacceptable material from the Site and provide new material conforming to the Contract Documents.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Supplemental Heat: Do not apply ceramic tile to surfaces that contain frost. Install ceramic tile only when substrate is at least 50 degrees F and rising. Maintain minimum temperature for curing period recommended under

applicable ANSI reference standard for the substrate and setting bed specified.

- a. Provide supplemental heat and protection as required to maintain ceramic tile at minimum of 50 degrees F during and after installation.
 - b. Supplemental heat and power sources, as may be required should ambient temperature fall below 50 degrees F, are not available at the Site. Provide supplemental heat, including fuel, equipment, operating and maintenance personnel and power sources.
 - c. Distribute heat uniformly and provide deflection or protective screens as required to prevent concentrating heat on ceramic tile near heat source.
2. Damp-cure latex-portland cement mortar setting bed under cover for minimum of 20 hours at temperatures of at least 70 degrees F and allow setting bed to dry before installing ceramic tile. Lower temperatures shall necessitate longer curing times. Comply with written recommendations of latex-portland cement mortar manufacturer.
 3. Warm Weather Requirements: Do not install ceramic tile when temperature of substrate is 100 degrees F or is expected to rise above 100 degrees F during curing period.

B. Site Measurements:

1. Where field measurements cannot be taken at the Site without delaying the Work, establish dimensions and proceed with Shop Drawing preparation without Site-verified dimensions. Coordinate supports, adjacent construction, and equipment locations to ensure dimensions shown on Shop Drawings correspond to dimensions established for ceramic tile Work.

1.8 SCHEDULING

- A. Do not install ceramic tile until other Work to be embedded in ceramic tile systems has been acceptably installed.
- B. Sequence the Work so that other installers do not interfere with or need to Work in the ceramic tile installation areas until such time as ceramic tile Work can be adequately protected from potential damage from their work, or access requirements.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:

1. Standards: Comply with applicable reference standards using this Section and recommendations of TCNA and ANSI, except to extent that more-stringent requirements are required in the Contract Documents.

2. All requirements of ANSI American National Standard Specifications for the Installation of Ceramic Tile, including its General Requirements, Forwards, and Explanation and Notes, shall be part of this Section.
3. Ceramic Tile Floor System Service Requirements, ASTM C627 and TCNA Performance-Level Requirement Guide and Selection Table:
 - a. Floors: Extra-Heavy.
 - b. Walls: Commercial Construction – Wet.
4. Environmental Profile: Provide environmentally-friendly ceramic tile manufactured using either a minimum of 55 percent recycled glass or post-industrial waste feldspar tailings as part of waste-free manufacturing process.
5. On exteriors, use only ceramic tile recommended by manufacturer as suitable for climatic conditions of the Site.

2.2 MATERIALS

A. Ceramic Tile, General:

1. Provide ceramic tile manufactured from shale and fire clays.
2. Comply with ANSI A137.1. Provide standard-grade ceramic tile. Seconds are unacceptable.
3. Where required to meet performance criteria specified, provide manufacturer's standard abrasive surfaced ceramic tile with fused aluminum oxide, uniformly impregnated on face of flat tile. Tiles showing an uneven distribution are unacceptable.
4. Provide ceramic tile with patterned backs. Dovetail backs are unacceptable.
5. Ceramic tile shall be precisely formed with uniform, straight edges and facial surfaces.

B. Ceramic Glazed Wall Tile:

1. Products and Manufacturers: Provide one of the following:
 - a. Bright Ceramic by American Olean Corporation.
 - b. Color Collection by United States Ceramic Tile Company, the Roca Tile Group.
 - c. Architettura by Marazzi USA, Marazzi Group.
 - d. Or equal.
2. Provide glazed wall tile with the following properties:
 - a. Percentage of Water Absorption, ASTM C373: 20 percent.
 - b. Abrasive Wear Resistance, ASTM C501: 158.
 - c. Breaking Strength, ASTM C648: 100 psi, minimum.
 - d. Warpage (diagonal), ASTM C485: plus-or-minus 0.4 percent.
 - e. Hardness, Mohs' Scale: 4.0 to 6.0, minimum.
3. Type: Single-fired, ceramic.
4. Grind glazed wall tile on all four sides of tile after firing.
5. Size: 4-1/4"x4-1/4".
6. Thickness: 5/16".
7. Provide complete selection of all special radiused cove base, bullnosed, shapes and other special trim shapes as shown, or as required for a complete

installation. Provide same material, color, size, and finish as floor tile, unless otherwise indicated in the Contract Documents.

8. Colors: Provide specified manufacturer's complete selection of standard and custom colors for final selection by ENGINEER. ENGINEER will select maximum of four colors.

C. Recycled Glazed Porcelain Floor Tile:

1. Products and Manufacturers: Provide one of the following:
 - a. Etiquette Series by American Olean
 - b. Glazed Porcelain Pavers by Daltile Corporation.
 - c. Porcelain Stone Tiles by Crossville, Inc.
 - d. Or equal.
2. Provide glazed ceramic floor tile with heavy-duty commercial glaze, manufactured primarily using waste feldspar tailings as raw material.
 - a. Percentage of Water Absorption, ASTM C373: 0.05 percent.
 - b. Craze Resistance, ASTM C424: Resistant.
 - c. Thermal Shock, ASTM C1026: No failure after five cycles.
 - d. Abrasive Wear Resistance, ASTM C501: 150.
 - e. Breaking Strength, ASTM C648: 400 psi, minimum.
 - f. Warpage (diagonal), ASTM C485: plus-or-minus 0.21 percent.
 - g. Hardness, Mohs' Scale: Eight, minimum.
 - h. Coefficient of Friction, ASTM C1028 and ADAAG: 0.60 minimum average of wet and 0.70 for dry leather for level floors; 0.80 minimum average of wet and dry leather for ramps.
3. Type: Waste feldspar tailings body, flux and glaze with wear rating acceptable and recommended by manufacturer for "heavy traffic" in commercial applications.
4. Size: 12"x12".
5. Thickness: 3/8".
6. Provide complete selection of special radiused cove base, bullnosed, inside and outside corner shapes, and other special trim shapes as shown, or as required by ENGINEER for a complete installation. Provide same material, size, color, and finish of floor tile, unless otherwise shown or specified.
7. Colors: Provide specified manufacturer's complete selection of standard and custom colors for final selection by ENGINEER. ENGINEER will select maximum of four colors.

D. Portland Cement: Comply with ASTM C150, Type 1, gray.

E. Aggregate: Provide sand complying with ASTM C144. Provide clean, graded sand passing a 16-mesh screen.

F. Mortar Setting Bed:

1. Provide thick/full bed setting bed for ceramic tiles.
2. Products and Manufacturers: Provide one of the following:
 - a. Laticrete 226 Thick Bed Mortar Mix gauged with Laticrete 3701 Mortar Admix by Laticrete International, Inc.

- b. Floor Mud and B-710 SBR Mortar Additive by ProSpec, a Sakrete Company.
 - c. Or equal.
 - 3. Latex-Portland Cement Mortar: Provide pre-blended, pre-sanded portland cement mortar with latex additives complying with ANSI A118.4.
 - 4. Physical Properties:
 - a. Compressive Strength, ASTM C109: 5,000 psi, minimum.
 - b. Hardness, ASTM D2240: 70 to 80 D-Scale; 72 hours.
 - c. Service Rating (TCNA), ASTM C627: Cycles 1 to 14 “extra heavy”.
 - d. VOC Content:
 - 1) Mortar: 0.00 g/L.
 - 2) Admixture: 2.39 g/L.
- G. Thin-Set Mortar:
- 1. Provide high-performance, high-tack, non-flammable, non-toxic, water cleanable, ceramic tile mortar.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Laticrete 272 Premium Floor N’ Wall Thin-Set Mortar gauged with Laticrete 3701 Mortar Admix by Laticrete International, Inc.
 - b. ProSpec Superior Permaflex 600 by Bonsal American, Inc.
 - c. Or equal.
 - 3. Latex-Portland Cement Bond Coat: Provide pre-blended, pre-sanded, portland cement mortar with latex additives complying with ANSI A118.4.
 - 4. Physical Properties: Provide the following:
 - a. Compressive Strength, ANSI A118.4: 2,500 psi, minimum.
 - b. Water Absorption, ANSI A118.7: Four percent, maximum.
 - c. Shear Bond, Porcelain Tile, Water Immersion, ANSI A118.4: 300 psi, minimum.
 - d. Service Rating (TCNA), ASTM C627: Cycles 1 to 14 “extra heavy”.
 - e. VOC Content: 0.00 grams per liter.
- H. Grout: Provide the following grout for areas receiving the Work of this Section:
- 1. Provide high-performance, premium sanded grout complying with ANSI A118.7 and recommended by grout manufacturer as acceptable for use in extra-heavy commercial and industrial applications.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Laticrete 500 Series gauged with Laticrete 1776 Grout Admix Plus by Laticrete International, Inc.
 - b. ProSpec Sanded Tile Grout (700) by, Bonsal American, Inc.
 - c. Or equal.
 - 3. Latex-Portland Cement Grout: Provide sanded cement grout consisting of blended mix of portland cement, graded aggregates, and color-fast pigments mixed with latex additive in place of water, complying with ANSI A118.7.
 - 4. Physical Properties:
 - a. Compressive Strength, ANSI A118.7: 3,500 psi, minimum.
 - b. Water Absorption, ANSI A118.7: Five percent, maximum.
 - c. Hardness, ASTM D2240: 60 to 70 D-Scale; 72 hours.

- d. Linear Shrinkage, ANSI A118.7: 0.19 percent, seven-day maximum.
- e. Service Rating (TCNA), ASTM C627: Cycles 1 to 14 “extra heavy”.
- f. VOC Content: 0.00 g/L.
- 5. Colors: Provide specified manufacturer’s complete selection of standard and custom colors for final selection by ENGINEER. ENGINEER will select maximum of four colors.

I. Auxiliary Materials:

- 1. Thresholds:
 - a. Provide sound Group “A” marble with an abrasive hardness of not less than 10.0 when tested in accordance with ASTM C241.
 - b. Provide beige colored, honed marble, complying with ASTM C503, for thresholds, where shown.
- 2. Burlap or Cheese Cloth: Provide to keep drainage layer free of mortar from mortar bed installation Work.
- 3. Temporary Protective Coating: Provide petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with melting point of 120 degrees F to 140 degrees F in compliance with ASTM C87, formulated to protect exposed ceramic tile surfaces against adherence of modified portland-cement mortars and grouts. Temporary protective coating shall be easily removable after grouting completion without damaging grout or tile.
- 4. Ceramic Tile Cleaner: Neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, and recommended for cleaning ceramic tile and modified portland-cement materials by the tile and grout manufacturers.
- 5. Sealants: Refer to Section 07 92 00, Joint Sealants.
- 6. Water: Clean and potable.

2.3 MIXES

A. Setting Bed Cement Mortar:

- 1. Provide latex-portland cement setting bed mortar mixed in accordance with ANSI A108.1 and manufacturer’s written specifications.
- 2. Machine-mix in mortar Supplier-approved mixer in which quantity of water is accurately and uniformly controlled.
- 3. Add only sufficient water to produce workable mix allowing for maximum compaction during tamping of mortar bed.

B. For mixing of bond coats, grouts, and similar materials, comply with manufacturer’s instructions and applicable ANSI reference standards using in this Section.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine the substrates to receive mortar bed and ceramic tile and conditions under which the ceramic tile Work will be performed. Notify ENGINEER in writing of unsatisfactory tolerances that exceed specified limits in other work adjoining the ceramic tile Work, and other conditions detrimental to proper and timely completion of the Work. Do not proceed with installing ceramic tile Work until unsatisfactory conditions have been corrected.
- B. Comply with recommendations for condition and inspection of surfaces, including tolerances, contained in the “Forward” and “General Requirements” of ANSI Specifications for the Installation of Ceramic Tile.

3.2 PREPARATION

- A. Prepare and cure substrates in accordance with ANSI A108.1, setting bed mortar manufacturer’s recommendations, TCNA recommendations, and installation methods in applicable ANSI reference standards used in this Section.
 - 1. Remove substances that are incompatible with ceramic tile setting materials by using terrazzo grinder, drum sander, or polishing machine equipped with heavy-duty wire brush.
- B. Provide structurally sound, dry substrate free of ridges and depressions and finished in accordance with installation method specified.
- C. Comply with ANSI suggestions for related trade preparations presented in the “Foreword” of ANSI American National Standard Specifications for the Installation of Ceramic Tile.
- D. Clean substrate of waxy and oily films and curing compounds.

3.3 INSTALLATION

- A. Install ceramic tiles in accordance with ANSI A108.1 and ANSI A10.20.
- B. Erection Tolerances:
 - 1. Limit out-of-plane variation of ceramic tile floor to 1/4-inch in 20 feet.
 - 2. Limit height offsets (lippage) between individual ceramic tiles to 1/32-inch.
 - 3. Limit joint width variation to plus-or-minus 1/16-inch in 20 feet.
- C. Ceramic Tile Tolerances:
 - 1. Comply with ASTM C499.
 - 2. Determine structural defects in flat tile and trim units in accordance with Appendix of ANSI A137.1.
- D. Install ceramic floor tile and thresholds in accordance with TCNA Handbook for Ceramic Tile Installation, as follows:
 - 1. Floor Tile: Handbook method F121-05, and in accordance with ANSI A108/118, except as otherwise specified.

2. Base Cove Alternative: Flush.
 3. Thresholds: Install stone thresholds complying with TCNA, "Handbook for Ceramic Tile Installation" Method TR611-2K.
- E. Ceramic Wall Tile: Install ceramic wall tile complying with TCNA, Handbook for Ceramic Tile Installation, as follows:
1. Wall Tile: Handbook method W211-latest version, and in accordance with ANSI A108.6, except as otherwise specified.
- F. Expansion Joints:
1. Install ceramic tile associated with expansion joints, control joints, and cold-joints in accordance with TCNA Handbook for Ceramic Tile Installation, Method EJ171-2K.
 2. Provide expansion joints in locations and in manner recommended by TCNA and as shown.
 3. Locate openings for expansion joints directly over structural joints in horizontal surfaces, where backing materials change and where ceramic tile Work abuts restraining surfaces such as perimeter walls, curbs, columns, piping, and conduits.
 4. Width of openings for expansion joints over structural joints shall be at least as wide as corresponding structural joint.
 5. Provide interior expansion joints same width as grout joints with minimum size of 1/4-inch.
 6. Provide exterior expansion joints of 3/4-inch. Refer to Section 07 95 13, Expansion Joint Cover Assemblies.
- G. Provide 95-percent mortar bond coat coverage for each ceramic tile back. Back butter each tile with bond coat or select a notched trowel sized to facilitate proper coverage, key mortar into substrate with flat side of trowel, and comb with notched side of trowel in one direction. Embed tile in mortar by beating-in, pushing in direction perpendicular to combed ridges, or other means to achieve 95 percent coverage. Corners and edges shall be fully supported by bonding mortar.
1. Periodically remove and check ceramic tile in presence of ENGINEER to ensure that proper coverage is being attained.
- H. Extend ceramic tile Work into recesses and under equipment, fixtures, and permanent furniture such as laboratory metal casework, lockers, and shop equipment to form complete covering without interruptions, except as otherwise shown or indicated. Terminate ceramic tile Work neatly at obstructions, edges, and corners without disruption of pattern or joint alignment. Provide standard pre-manufactured trim components.
- I. Accurately form intersections and returns. Perform cutting and drilling of ceramic tile without marring visible surfaces.
- J. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight, aligned joints. Cut and ground edges shall be uniform and straight without

- marring tile faces. Extend ceramic tile half-way under door thresholds. Fit ceramic tile closely to electrical outlets, piping, conduit, and fixtures so that plates, collars, or covers overlap ceramic tile. Use bullnosed tile adjacent to carpet.
- K. Jointing Pattern: Unless otherwise shown or indicated, lay ceramic tile in grid pattern. Align joints when adjoining ceramic tile on floor, base, and trim are same size. Lay out ceramic tile Work and center tile fields both directions in each space. Adjust to minimize tile cutting. Provide uniform 3/16-inch joint widths for floors.
 - L. Grout joints (except control and expansion joints) with specified grout, in accordance with ANSI A108.10.
 - 1. Dampen tile surfaces with water. Spread grout with a sharp, firm, rubber grout float. Work the grout paste into the joints until completely filled. Use diagonal strokes to pack the tile joints. Ensure that joints are filled and that grout is not bridging the joint.
 - 2. Provide full flush joints for ceramic floor tiles by sprinkling thin layer of dry grout powder over surface immediately after grouting. When grout darkens over joint, buff with burlap, carpet remnant, or cotton rag to pack joint and clean face of tile.
 - M. Protect ceramic tile against damage from high performance grout by coating exposed faces of tile with wax coating to produce a thin, continuous film. Use wax that is compatible with grout and is removable by steaming method approved by tile and grout manufacturer. Apply wax in manner to avoid coating edges or backs, and handle coated tile to prevent waxed surfaces from contacting the backs or edges or other units.
 - N. Cure ceramic tile Work using materials and techniques recommended by mortar and grout manufacturer and ANSI A108.5.
 - O. Do not use chipped, cracked, or defaced ceramic tile.
 - P. Provide divider strips and accent strips to same depth as finished ceramic tile floor and wall system, including setting bed.

3.4 ADJUSTMENT AND CLEANING

- A. Remove grout and mortar from ceramic tile faces and adjoining Work before grout or mortar hardens. Follow grout and mortar manufacturer's written recommendations for primary and secondary cleaning. Leave ceramic tile clean and free of foreign matter.
- B. Prohibit traffic from using ceramic tile floors for seven days after grouting is completed.

- C. Before traffic is allowed over finish ceramic tile floors, cover with heavy building paper.
- D. Lay board walkways on floors that are to be trucked-over. Provide continuous runways of required width installed over building paper.
- E. Remove protective wax surfacing in accordance with ceramic tile manufacturer's recommendations.
- F. Do not acid clean unglazed ceramic tile unless allowed by ceramic tile manufacturer's printed instructions and, if allowed, do so no earlier than 14 days after grouting. Mild acid cleaners that do not contain muriatic acid will be acceptable if recommended by ceramic tile manufacturer. Where acid cleaners are acceptable, comply with the following:
 - 1. Soak unglazed ceramic tile with water before cleaning with saturated solution of sulfuric acid in room temperature water.
 - 2. Protect metal and enamel surfaces, and cast iron and vitreous plumbing fixtures, from effects of acid cleaning by coating such items with petroleum jelly.
 - 3. Thoroughly flush ceramic tile with water before and after acid cleaning and restore protected surfaces to their original condition.
- G. Do not use acid or acid-based cleaners to clean glazed ceramic tile.
- H. Remove cracked, broken, unbounded, or damaged ceramic tile and replace with new material.
- I. Protection:
 - 1. Protect adjoining work from the Work of this Section.
 - 2. Where acid solutions are required to clean surfaces of finished Work, first cover exposed adjoining work to protect adjoining work from possible effect of acid or its fumes.
 - 3. Clean adjoining surfaces soiled by ceramic tile Work.
 - 4. Replace adjoining work damaged beyond repair by the Work of this Section.
- J. Immediately prior to inspection to determine Substantial Completion, remove protective coverings and wash ceramic tile floors and walls clean.

+ + END OF SECTION + +

+ +NO TEXT ON THIS PAGE+ +

SECTION 09 65 05

RESILIENT FLOORING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install resilient flooring.
2. Extent of resilient flooring is shown.
3. Types of products required include the following:
 - a. Homogeneous, resilient rubber tile.
 - b. Resilient rubber sanitary cove base and pre-molded sanitary cove base corners.
 - c. Edging strips.
 - d. Environmentally safe, high performance, polyurethane, rubber tile adhesive.
 - e. Environmentally safe, fortified acrylic, sanitary cove adhesive.
 - f. Miscellaneous rubber accessories, fillers and fasteners.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with or before, the resilient flooring Work.
2. Coordinate requirements for maximum safe moisture-emission level of concrete slabs in compliance with resilient flooring manufacturer's written recommendations and in compliance with ASTM E 1643 and Section 03 30 05, Concrete.
3. Coordinate the finishing of substrates for acceptability of substrates to resilient flooring manufacturer, as indicated on approved Shop Drawings.
4. Remove all chemicals, compounds and other materials from substrates to receive the Work of this Section, as may be required by the resilient flooring manufacturer, even if other Sections permit chemicals, compounds and other materials.

C. Related Sections:

1. Section 03 30 05, Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Society for Testing and Materials, (ASTM).

- a. ASTM C 501, Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
- b. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
- c. ASTM D 570, Test Method for Water Absorption of Plastics.
- d. ASTM D 2047, Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
- e. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
- f. ASTM D 4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
- g. ASTM E 648, Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
- h. ASTM E 662, Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
- i. ASTM E 1643, Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- j. ASTM F 386, Test Method for Thickness of Resilient Flooring Material Shaving Flat Surfaces.
- k. ASTM F 540, Test Method for Squareness of Resilient Tile Flooring by Dial Gage Method.
- l. ASTM F 710, Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- m. ASTM F 925, Test Method for Resistance to Chemicals of Resilient Flooring.
- n. ASTM F 1344, Specification for Rubber Floor Tile.
- o. ASTM F 1861, Specification for Resilient Wall Base.
2. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG.
3. International Standards Organization, (ISO)
 - a. ISO, 9002, Quality Systems - Model for Quality Assurance in Production, Installation and Servicing.
4. Resilient Floor Covering Institute, (RFCI), Addressing Moisture Related Problems Relevant to Resilient Floor Coverings Installed Over Concrete.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 1. Provide all components of resilient flooring system and auxiliary products produced by a single manufacturer, including recommended primers, adhesives and edging strips, as required.
 2. Provide products from manufacturer who participates in ISO certification programs and who manufacture resilient flooring systems and auxiliary products conforming to the requirements of those programs.

B. Installer's Qualifications:

1. Engage a single installer regularly performing installation of resilient flooring with documented skill and successful experience in the installation of the types of materials required; and who agrees to employ only tradesmen who are trained, skilled and have successful experience in installing the types of materials specified.
2. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
 - a. Names and telephone numbers of owners, architects or engineers responsible for projects.
 - b. Approximate contract cost of the resilient flooring.
 - c. Amount of area installed.

C. Source Quality Control:

1. Furnish all components of resilient flooring system from a single manufacturer, and from a single supplier with adequate resources to provide products of consistent performance characteristics, physical properties and appearance, without delaying the Work.
2. Obtain materials only from manufacturers who will, if required, send a qualified technical representative to the Site, for the purpose of advising installer of proper procedures and precautions for the use of the materials.
3. Provide products from manufacturers who participate in ISO 9002 Quality Control Programs.
4. Colors and Patterns: Provide resilient floor tile and stair-covering units with uniformly distributed color and pattern throughout the thickness of the tile, except as otherwise specified. Variation in shades and off pattern matches between containers will not be acceptable.

D. Definitions:

1. Critical Radiant Flux (CRF): According to ASTM E 648, the measure of the ability of a floor covering to resist the spread of flames when located in a corridor exposed to flames and hot gases from a room fire. The higher the CRF value, the more resistant the material is to flame spread.
2. Excessive Wear: Loss of thickness of more than 0.0025-inches of rubber material per year based on specified traffic conditions.
3. Low Vibration Profile: The combination of resilient rubber compounds and tile profile design that will eliminate or noticeably reduce vibration of wheeled vehicles. Wheels of 4-inch diameter or greater should cause no vibration or noticeable sound and should not contribute to ambient noise.
4. Migrating Waxes: Waxes and soil-releasing agents that are chemically a component of the product's formulation, continually traveling to the product's surface when activated by use.
5. Non-Solvent Adhesives: Adhesives with a non-solvent base requiring no open time to permit solvent flash.
6. Optical Smoke Density: The optical density of smoke developed by burning a solid material, such as resilient flooring, established according to ASTM E 662.

E. Regulatory Requirements:

1. Wherever a flame spread, smoke development or CRF classification is shown or specified for resilient flooring (Class B, Class I and similar designations), provide components complying with applicable requirements for materials and installation established by ASTM, and other governing authorities having jurisdiction at the Site.

F. Mock-Ups:

1. Before proceeding with final purchase of materials and installation of resilient flooring systems, but after ENGINEER'S approval of Samples and Shop Drawings, install 100 square foot samples of each component of resilient flooring system, and one landing and run of stairs including all stair flooring components and accessory trim, indicating the final relationship and configurations of the various parts and components and the quality of workmanship that will be achieved in the Work. Locate mock-ups in areas selected by ENGINEER to show a representative installation of each type of resilient flooring system.
2. Incorporate materials and methods of installation that are identical to Project requirements.
3. Obtain ENGINEER'S acceptance of visual qualities of mock-up before start of resilient flooring system Work. Retain and protect mock-up during construction as a standard for judging completed resilient flooring. Do not alter or remove approved mock-ups.
4. Build as many mock-ups as required to obtain ENGINEER'S acceptance. Disassemble rejected mock-ups and remove all components from Site. Do not incorporate rejected mock-up components into the Work. Accepted mock-up may be incorporated into the finished Work.
5. Resilient flooring system Work that proceeds without approved mock-ups shall be stopped, and mock-ups prepared for ENGINEER'S approval.
6. Resilient flooring that does not meet the standard of workmanship on approved mock-ups shall be removed and replaced with new material.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Plans drawn to a scale of 1/4-inch equal to 1 foot-0 inch showing all flooring and all stair covering units and components accurately located in final positions as they will occur in the finished Work, and showing actual dimensions of areas to receive the Work. Show all patterns required for the Work and the location of each color and texture required for each tile pattern.
 - b. Details drawn to a scale of 1-1/2-inches equal to 1 foot-0 inch showing all intersections of stair covering components with actual dimensions of stair treads, risers, landings and stringers and with all products

accurately located and positioned as they will occur in the finished Work.

2. Product Data:
 - a. Copies of manufacturer's specifications and installation instructions for each type of resilient flooring, stair floor covering, auxiliary material and accessory required.
 3. Samples: Submit the following:
 - a. Each type and color of resilient flooring and stair floor covering required. Provide full size samples of each type of flooring and stair covering product and 12-inch lengths of each auxiliary product and accessory specified.
 - b. Samples shall show the full range of color and pattern variation. Sample submittals will be reviewed for color, texture and pattern only. Compliance with all other requirements is the responsibility of CONTRACTOR.
- B. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data: Furnish five copies of manufacturer's instructions for recommended maintenance practices for each type of resilient flooring and stair floor covering.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
 2. Deliver materials to the Site in the manufacturers' original, unopened, undamaged containers and packages, with intact and legible labels indicating brand names, colors, patterns and type of system component as approved by ENGINEER.
 3. Move products into spaces where they will be installed 48 hours before installation, unless longer conditioning period is recommended, in writing, by the resilient flooring manufacturer.
 4. Prevent surface wax from transferring to back surface of resilient flooring by handling in a manner that keeps back-to-back and face-to-face orientation.
- B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store and protect accepted materials in accordance with manufacturer's written directions and recommendations.
 3. Unless otherwise directed, by the ENGINEER, store materials in original containers and under complete enclosure, protected from all weather and construction traffic, and continuously maintained at 68°F.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.
2. Inspect materials and reject components differing from approved Samples and Shop Drawings. Immediately remove rejected components from the Site.
3. Do not open containers or remove markings until materials are inspected and accepted. Packages with illegible or removed labels will be rejected for use in the Work.

1.6 JOB CONDITIONS

A. Environmental Requirements:

1. Do not begin installation until permanent environmental control systems are operating as needed to maintain consistent temperatures in installation areas. Continuously maintain temperature in areas to receive resilient flooring systems at 68°F for at least 48 hours prior to, during, and 48 hours after installation.
2. Perform moisture testing of cast-in-place concrete slabs when temperature in the spaces where resilient flooring will be installed is greater than 50°F.

B. Scheduling:

1. Schedule the arrival of materials to minimize storage on-Site and only as required by manufacturer to allow materials to acclimate to areas of installation.
2. Store only sufficient quantities of material on-Site as required to advance the Work without causing delays.
3. Close spaces to traffic during flooring installation and for time period after installation recommended, in writing, by the resilient flooring manufacturer.
4. Install resilient flooring after other finishing operations, including painting, have been completed.
5. Where demountable partitions and similar demountable items are indicated for installation on top of resilient flooring, install resilient flooring before these items are installed.

1.7 WARRANTY

- A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Special Warranties:

1. Resilient Flooring Wear Warranty: Provide written warranty, signed by CONTRACTOR and manufacturer and running to benefit of OWNER, agreeing to replace, for a period of ten years from the date of Substantial Completion, resilient tile units that show excessive wear, as specified.
2. Resilient Stair Floor Covering System Wear Warranty: Provide written warranty, signed by CONTRACTOR and the manufacturer and running to the benefit of OWNER, agreeing to replace, for a period of ten years from the date of Substantial Completion, resilient stair coverings that shows signs of excessive wear, as specified.

1.8 EXTRA MATERIALS

A. Extra Materials:

1. Furnish extra materials from the same manufactured lot as the materials installed.
2. Unless otherwise directed by the ENGINEER, furnish two percent of each type and color of resilient flooring, stair floor covering, auxiliary material and accessory used in the Work and store in a secure area at the Site as directed by OWNER.
3. Do not provide partial containers or packages of materials. Round-up quantities to furnish only complete, unopened and undamaged containers and packages; with legible labels accurately representing contents of container or package indicating compliance with approved Samples and Shop Drawings, and matching materials actually installed.
4. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used on this Project, with calculations establishing quantity of extra materials to be furnished to OWNER.
5. Do not furnish materials whose remaining shelf life will be less than six months, at the time of Substantial Completion. Furnish only materials that are accompanied by a documented record of proof of being continuously stored and handled according to manufacturer's recommended storage and temperature limitations.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Description:

1. Resilient flooring systems shall include a system of rubber flooring tile, sanitary cove base moldings and factory-pre-molded outside and inside sanitary cove base molding corners and all auxiliary and accessory products, adhesives and fillers.
2. The system shall also include all necessary vapor retarders and underlayments, specified and installed under other Sections, and all surface

preparation, and testing to provide a complete system, and acceptable performance, complying with the requirements of these Specifications.

B. Performance Criteria:

1. Static-Load Resistance: 600 psi, without permanent denting.
2. Optical Smoke Density, ASTM E 662: Less than 450.
3. Critical Radiant Flux (CRF), ASTM E 648: Not less than 0.45 watts per square centimeter; Class 1.
4. Slip Resistance, ASTM D 2047 and ADAAG Appendix A4.5: Not less than 0.6 static coefficient of friction (James Test), for horizontal surfaces.

2.2 MATERIALS

A. General: Manufactured units shall contain no polyvinylchloride or other halogens, and shall be completely asbestos-free.

B. Rubber Tile:

1. Furnish homogeneous, hammered-surface, sprinkled-pattern units, rated for ultra-low vibration and manufactured using 100 percent synthetic, virgin, styrene-butadiene, vulcanized rubber, free from reground rubber, natural rubber or coarse fillers. Furnish tiles with body composition comprising 44 percent rubber with pigments, fillers and plasticizers and with surface color or mottling extending throughout the entire thickness of the tile; smooth double-sanded back, complying with ASTM F 1344, Class I.
2. Physical Properties: Provide the following:
 - a. Abrasion Resistance, ASTM C 501 (H-18 Wheel, 500-gram load, 1,000 cycles): 0.40-gram loss weight, maximum.
 - b. Hardness, ASTM D 2240 (Shore A): 85, minimum.
 - c. Elongation, ASTM D 412: 200 percent, minimum.
 - d. Tensile Strength, ASTM D 412: 900 psi.
 - e. Water Absorption, ASTM D 570: 0.3 percent, maximum.
 - f. Chemical Resistance, ASTM F 925:

<u>Reagent</u>	<u>Resistance</u>	<u>24 Hours</u>
Acetic Acid	5 percent	No Change
Ammonia	28 percent	No Change
Lactic Acid	90 percent	No Change
Coffee/Tea		No Change
Concentrated Cleaners		No Change

3. Size and Thickness: 39.37-inches by 39.37-inches by 0.14-inches thick, minimum.
4. Colors:
 - a. Complete selection of manufacturer's standard and custom colors for final selection by ENGINEER.
 - b. ENGINEER will select a maximum of two colors.
5. Products and Manufacturers: Provide one of the following:

- a. Norament 925 B Grano and Norament 925 B Lago - Article 1880 Heavy Traffic by Nora Rubber Flooring - Freudenberg Building Systems, Incorporated.
 - b. Or equal.

- C. Sanitary Base Cove Molding: Rubber wall-base complying with ASTM F 1861, Type TS, thermoset, vulcanized, styrene-butadiene rubber; 0.125-inches thick with connection dimension matching final resilient tile thickness; approximate 4 foot-0 inch long sections, with matching end stops and pre-molded inside and outside corner units, as follows:
 - 1. Size: 4-inches high.
 - 2. Colors:
 - a. Complete selection of manufacturer's standard and custom colors for final selection by ENGINEER.
 - b. ENGINEER will select a maximum of one color.
 - 3. Products and Manufacturers: Provide one of the following:
 - a. BurkeBase Thermal-Set Rubber by Burke Flooring Products a Division of Burke Industries.
 - b. Or equal.

- D. Accessories:
 - 1. Feature Strips: Complete selection of thermosetting rubber strips, including transitional reducers, thresholds, tile joiners and caps. Size and color as shown, of the same material composition and thickness as the adjacent flooring units.
 - 2. Edging Strips: 1/8-inch thick, homogenous, thermosetting rubber, tapered or bullnosed edge, color as selected by ENGINEER from manufacturer's custom and standard colors.
 - 3. Metal Edge Strips: Width shown, of required thickness to protect exposed edge of resilient flooring. Provide units of maximum available length, to minimize number of joints.
 - a. Material: Extruded aluminum with mill finish, unless otherwise shown.
 - b. Type: Butt-type metal edge strips for concealed anchorage.

- E. Auxiliary Products:
 - 1. Concrete Slab Primer: Non-staining type recommended by the resilient flooring manufacturer.
 - 2. Cementitious Underlayment: As recommended by the resilient flooring manufacturer.
 - 3. Sanitary Base Cove, Non-Solvent Adhesive: Provide a fortified acrylic emulsion recommended by the resilient flooring manufacturer.
 - 4. Flooring and Stair Floor Covering, Non-Solvent Adhesive: Provide a high performance, solvent-free, two-part polyurethane adhesive with excellent resistance to moisture, heat and humidity.
 - 5. Epoxy Nose-Filler and Adhesive: Provide solvent-free, non-sag epoxy as recommended by resilient flooring manufacturer to completely fill all stair

nosings to prevent cracking or flexing of treads and nosings by uniformly molding a bonding support for the step.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the areas and conditions under which resilient flooring Work will be performed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

- A. Do not install products until they are at the same temperature as the space where they are to be installed.
- B. Ensure that surfaces to receive resilient flooring are sufficiently cured, dry and are ready to receive resilient flooring installation as recommended by manufacturer, in writing.
- C. Prepare cast-in-place concrete slabs in compliance with ASTM F 710. Remove substances incompatible with resilient flooring and adhesives using methods recommended, in writing, by the resilient flooring manufacturer.
- D. Test cast-in-place concrete for moisture, in compliance with ASTM D 4263 and in compliance with RFCL. Perform testing, as developed by the Rubber Manufacturers Association calcium chloride test, in order to determine that the maximum safe moisture-emission level recommended by the resilient flooring manufacturer's written installation limitations will not be exceeded, before installation of resilient flooring.
 - 1. Allow thirty days drying time for each 1-inch of cast-in-place concrete slab thickness before testing concrete.
 - 2. Perform minimum of one test for every 1,000 square feet of floor area to receive resilient flooring.
 - 3. If moisture tests indicate unacceptable levels of moisture remaining in the slab, do not install resilient flooring. Report existing conditions, along with recommendations, to ENGINEER, in writing. Allow additional time for slab to dry and retest.
 - 4. CONTRACTOR may, at their option and expense, dehumidify or provide additional heat, in order to speed the drying process. If, after remediation measures are implemented, retesting the cast-in-place concrete continues to indicate unacceptable levels of moisture, submit resilient flooring manufacturer's recommended penetrating-sealer and remedial moisture barrier product for ENGINEER'S approval.

- E. Perform one adhesive bond test for every 2,000 square feet of area receiving resilient flooring, but not less than one in each space, to verify acceptable adhesion of resilient flooring manufacturer's approved adhesive. Examine after 72 hours to determine whether bond is solid and no moisture is present. Do not proceed with Work until bond tests produce acceptable results.
- F. Installation Surfaces:
1. Survey surfaces to receive resilient flooring and verify tolerances are within limits specified. Do not install resilient flooring where surfaces are outside of allowable tolerances specified.
 2. Use leveling compound as recommended by resilient tile manufacturer for filling small cracks and depressions in installation surfaces.
 3. Level cast-in-place concrete surfaces, to receive resilient flooring, to provide concrete level to within 1/8-inch variation in ten-feet. Comply with recommendations of both the cementitious underlayment manufacturer's and resilient flooring manufacturer's written and approved recommendations for product compatibility and installation.
 4. Concrete floors with slick finish or with curing or hardening compounds shall be mechanically abraded using methods approved by the resilient flooring manufacturer.
 5. Prior to start of installation of resilient tile units, clean all surfaces to be covered with resilient flooring using high-efficiency particulate air filter vacuum cleaners and inspect the subfloor in accordance with manufacturer's instructions.
- G. Concrete Primer: Apply concrete slab primer if recommended by resilient flooring manufacturer, prior to application of the adhesive. Apply in compliance with manufacturer's written and approved instructions.

3.3 FIELD QUALITY CONTROL

- A. Allowable Tolerances:
1. Surfaces to Receive Resilient Flooring Systems: Surface shall be smooth, level, at the required finish elevation, without more than 1/8-inch in ten feet variation from level, or slopes, shown. Provide surfaces free of depressions, raised areas, or other defects that may telegraph through installed flooring.
 2. Rubber Flooring Thickness: In accordance with the requirements of ASTM F 386.
 3. Rubber Flooring Squareness: In accordance with the requirements of ASTM F 540.

3.4 INSTALLATION

- A. Place resilient flooring units using manufacturer's dry laying installation method with all embossed arrows pointing in the same direction and with adhesive cement mixed in strict compliance with the manufacturer's written and approved

installation instructions. Follow all product use precautions as recommended by the manufacturer.

- B. Butt resilient flooring units tightly to vertical surfaces, thresholds, nosings and edgings. Scribe around obstructions to produce neat joints, laid tight, even and in straight, parallel lines. Extend resilient flooring units into toe spaces, door reveals, and into closet and similar openings.
- C. Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on the finish resilient flooring as marked on the subfloor. Use chalk or other non-permanent marking devices.
- D. Install resilient flooring on covers for telephone, electrical ducts and floor hatches, and other such items as occur within the finished resilient flooring areas. Maintain the overall continuity of color, joints, and pattern with resilient flooring installed on these covers. Tightly cement edges of resilient flooring to perimeter of sanitary cove base.
- E. Lay resilient flooring from center marks established with principal walls, discounting minor offsets, so that resilient flooring at opposite edges of the room are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay resilient flooring square to room axis, unless otherwise shown.
- F. Match resilient floorings for color and pattern by using resilient flooring from cartons in the same sequence as manufactured and packaged. Cut resilient flooring neatly around all obstructions. Broken, cracked, chipped or deformed resilient flooring shall be replaced.
- G. Apply resilient flooring to flooring surfaces using a full spread of adhesive applied to flooring surface to comply with resilient flooring manufacturer's written approved instructions, including those for notching, adhesive mixing, and adhesive open and working times.
- H. Tightly cement resilient flooring to flooring surfaces without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks through resilient tile, or other surface imperfections.
- I. Lay resilient flooring in "checkerboard" fashion with grain reversed in alternate resilient tiles.
- J. Place resilient edge strips tightly butted to resilient flooring and secure with adhesive. Provide edging strips at all unprotected edges of resilient flooring, unless otherwise shown.
- K. Sanitary Cove Wall-Base: Apply to all columns, pilasters, casework and other permanent fixtures in rooms or areas where base is required. Install base in as

long lengths as practicable, with preformed corner units. Tightly bond base to backing throughout the length of each piece, with continuous contact at horizontal and vertical surfaces.

1. On masonry surfaces, or other similar irregular surfaces, fill voids along top edge of resilient wall-base with manufacturer's recommended adhesive filler material.
2. Install pre-molded outside and inside corners before installing straight pieces.

L. Metal Edge Strips:

1. Apply butt-type metal edge strips where shown and prior to installing resilient flooring. Secure units to substrate with countersunk stainless-steel screws, complying with manufacturer's recommendations for the type of substrate.

M. Resilient Accessories:

1. Apply resilient accessories so they are butted to adjacent materials and bond to surfaces with adhesive. Install reducer strips at edges of flooring that would otherwise be exposed.
2. Apply resilient products to stairs as shown and according to approved Shop Drawings and manufacturer's approved written instructions. Apply nose-filler for all stair tread nosings.

3.5 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing resilient products:

1. Remove all adhesive and other surface blemishes from resilient flooring, using neutral-type cleaners as recommended by the resilient flooring manufacturer.
2. Vacuum floor thoroughly.
3. Do not wash floor until after time period recommended by resilient flooring manufacturer.
4. Damp-mop floor to remove marks and soil.

B. Protect installed flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of the construction period and to Substantial Completion. Use protection methods recommended in writing by the resilient flooring manufacturer.

C. Do not move heavy or sharp objects directly over floor surfaces. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

D. Clean floor surfaces not more than four days before scheduled inspection to determine Substantial Completion of the Work. Clean products according to manufacturer's approved written recommendations.

- E. Resilient flooring system components, damaged for any reason, shall be replaced with new, undamaged material, in compliance with the requirements of these Specifications, at no additional cost to the OWNER.

+ + END OF SECTION + +

SECTION 09 91 00

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
 - a. CONTRACTOR is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included in the general contract and other contracts described in this Section.
 - a. CONTRACTOR is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included under this and other Sections.
2. Extent of painting includes the Work specified below. Painting shown in schedules may not provide CONTRACTOR with complete indication of all painting Work. Refer to Article 2.2 of this Section where all surfaces of generic types specified are specified for preparation and painting according to their status, intended function, and location, using the painting system for that surface, function, and location as specified, unless specifically identified on the Drawings as a surface not to receive specified painting system.
 - a. All new and specifically identified existing surfaces and items except where natural finish of material is specified as a corrosion-resistant material not requiring paint; or is specifically shown as indicated by written note, or specified as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.
 - b. Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by OWNER, are included in the Work, except as otherwise shown or specified.
 - c. Removal of all substances, top coats, primers and all intermediate coats of paint and other protective or decorative coatings on those items and surfaces to remain that are identified to receive a painting system under this Section, to provide surfaces acceptable for application of painting specified.

B. Coordination:

1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.
2. Coordinate painting of areas that will become inaccessible once equipment and similar fixed items have been installed.

3. Furnish information to ENGINEER on characteristics of finish materials proposed for use and ensure compatibility with prime coats used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify ENGINEER in writing of anticipated problems using specified painting systems with surfaces primed by others. Reprime equipment primed in factory and other factory-primed items that are damaged or scratched.
- C. Related Sections:
1. Section 02 82 33, Lead-Based Paint Abatement.
 2. Section 02 83 19, Non-Liquid PCB Material Removal.
 3. Section 03 01 30, Repair and Rehabilitation of Cast-In-Place Concrete.
 4. Section 07 92 00, Joint Sealants.
- D. Work Not Included: The following Work is not included as painting Work, or are included under other Sections or in other contracts:
1. Shop Priming: Shop priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-painted process equipment, plumbing equipment, heating and ventilating equipment, electrical equipment, and accessories shall conform to applicable requirements of this Section but are included under other Sections or in other contracts.
 2. Pre-finished Items:
 - a. Items furnished with such finishes as baked-on enamel, porcelain, and polyvinylidene fluoride shall only be touched up at Site by CONTRACTOR using manufacturer's recommended compatible field-applied touchup paint.
 - b. Items furnished with finishes such as chrome plating or anodizing.
 3. Concealed Surfaces: Non-metallic wall or ceiling surfaces in areas not exposed to view, and generally inaccessible areas, such as furred spaces, pipe chases, duct shafts, and elevator shafts.
 4. Concrete surfaces below elevation 59.00, unless otherwise shown or specified.
 5. Concrete floors, unless specifically shown as a surface to be painted.
 6. Face brick, glazed structural tile, and prefaced, ground-faced or split-faced concrete unit masonry.
 7. Exterior face of architectural precast concrete.
 8. Collector bearings, shafts and chains, wood flights, wood stop logs, and wood or fiberglass baffles.
 9. Corrosion-Resistant Metal Surfaces: Where the natural oxide of item forms a barrier to corrosion, whether factory- or Site-formed, including such materials as copper, bronze, muntz metal, terne metal, and stainless steel.
 10. Operating Parts and Labels:
 - a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors, and fan shafts.

- b. Do not paint over labels required by governing authorities having jurisdiction at Site, or equipment identification, performance rating, nameplates, and nomenclature plates.
 - c. Cover moving parts and labels during the painting with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings, and splatter that comes in contact with such labels.
 - 11. Structural and miscellaneous metals covered with concrete need not receive primers, intermediate, or finish coats of paint.
- E. Description of Colors and Finishes:
- 1. Color Selection:
 - a. ENGINEER reserves the right to select non-standard colors for paint systems specified within ability of paint manufacturer to produce such non-standard colors. Provide such colors at no additional expense to OWNER.
 - 2. Color Coding of Pipelines, Valves, Equipment, and Ducts:
 - a. Color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1, CFR 1910.144, Recommended Standards for Water Works, and Recommended Standards for Wastewater Facilities. For piping and equipment not covered by the above standards, conform to OWNER's color standards.
 - b. For equipment located on roofs and equipment that is exposed-to-view, color will be selected by ENGINEER.

1.2 REFERENCES

- A. Referenced Standards: Standards referenced in this Section are:
- 1. ANSI A13.1, Scheme for Identification of Piping Systems.
 - 2. ANSI Z535.1, Safety Color Code.
 - 3. ASTM D16, Terminology for Paint, Related Coatings, Materials and Applications.
 - 4. ASTM D2200, Pictorial Surface Preparation Standards for Painting Steel Surfaces.
 - 5. ASTM D4262, Testing Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
 - 6. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - 7. ASTM D4541, Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
 - 8. ASTM E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - 9. Great Lakes Upper Mississippi River Board of Public Health and Environmental Managers (GLUMRB) Recommended Standards for Water Works.
 - 10. GLUMRB, Recommended Standards for Wastewater Facilities.

11. Ozone Transport Commission, (OTC), OTC Model Rule for Architectural and Industrial Maintenance Coatings.
12. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
13. SSPC VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
14. SSPC VIS 2, Method of Evaluating Degree of Rusting/Painted Steel Surfaces.
15. SSPC Volume 2, Systems and Specifications.

1.3 DEFINITIONS

- A. Coating terms defined in ASTM D16 apply to this Section.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications:
 1. Engage a single applicator regularly performing installation of painting systems, with documented skill and successful experience in installing types of products required and agrees to employ only tradesmen trained, skilled, and with successful experience in installing types of products specified.
- B. Testing Agency Qualifications: Provide independent testing agency with experience and capability to satisfactorily conduct testing specified in accordance with ASTM E329. Testing agency shall be selected by OWNER and paid for by CONTRACTOR.
- C. Source Quality Control:
 1. Obtain products from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work to advise on products, mock-ups, installation, and finishing techniques, at completion of the Work to advise ENGINEER on acceptability of completed Work, and during course of Work as requested by ENGINEER.
 2. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and recoatability after curing.
 3. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in painting systems.
 4. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services indicated. Comply with the following:
 - a. Lead and Chromate: Lead and chromate content shall not exceed amount allowed by authorities having jurisdiction.
 - b. Through CONTRACTOR, paint manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in areas subject to hydrogen sulfide fume exposure.
 - c. Manufacturer shall identify colors that meet requirements of authorities having jurisdiction at Site for use in locations subject to

contact with potable water or water that will be treated to become potable.

- d. Comply with paint manufacturers' recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint coatings.

D. Regulatory Requirements:

1. Comply with VOC content limits of Ozone Transport Commission (OTC), Model Rule for Architectural and Industrial Maintenance Coatings.

E. Pre-Painting Conference:

1. Conduct a pre-painting conference at the Site to review specified requirements. Meeting attendees shall include painting applicator and its foreman, paint manufacturer's technical representative, installers of other work in and around painting that must follow painting Work, ENGINEER, and other representatives directly concerned with performance of painting Work.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Copies of manufacturer's technical data sheets, including surface preparation, number of coats, dry film thickness, test performance data including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contact Documents, and application instructions for each product proposed for use.
 - b. Submit proof of acceptability of proposed application techniques by paint manufacturer selected.
 - c. Copies of CONTRACTOR's proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.
 - d. List each material and cross-reference to the specific painting system and application, including a list of site-specific surfaces to which painting system will be applied. Identify by manufacturer's catalog number and general classification. State number of gallons of each product being purchased for delivery to Site and square foot area calculated to be covered by each painting system specified based on theoretical loss of 20 percent. Where actual area to be covered by paint system exceeds area submitted to ENGINEER for that system, proof of additional material purchase shall be provided to ENGINEER. Calculated coverage shall be as specified for each component of each

painting system specified. This requirement does not take precedence over CONTRACTOR's responsibility to provide dry film thickness required for each component of each painting system.

- e. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.
 - f. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.
 - g. Specification for spray equipment with cross-reference to paint manufacturer's recommended equipment requirements.
2. Samples:
- a. Copies of manufacturer's complete color charts for each coating system.

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.
 - b. CONTRACTOR shall provide notarized statement verifying that all painting systems are compatible with surfaces specified. All painting systems components shall be reviewed by an authorized technical representative of paint manufacturer for use as a compatible system. Verify that all painting systems are acceptable for exposures specified and that paint manufacturer is in agreement that selected systems are proper, compatible, and are not in conflict with paint manufacturer's recommended specifications. Show by copy of transmittal form that a copy of letter has been transmitted to paint applicator.
- 2. Test Reports:
 - a. Certified laboratory test reports for required performance and analysis testing in compliance with ASTM E329.
 - b. Adhesion testing plan and procedures.
 - c. Results of adhesion testing on existing surfaces containing paints or other coatings to be topcoated with paint systems specified. Prior to adhesion testing, submit a testing plan establishing methods, procedures and number of tests in each area where existing coatings are to remain and become substrate for painting Work. Based on results of adhesion testing, recommend methods, procedures, and painting system modifications, if necessary, for proceeding with Work.
 - d. Locations of and test methods for soil sampling before beginning Work and after Substantial Completion.
 - e. Proposed methods for testing, handling, and disposal of waste generated during Work.
 - f. Results of alkalinity and moisture content tests performed per ASTM D4262 and ASTM D4263.

- g. Results of film thickness, holidays, and imperfections tests.
 - 3. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.
 - 4. Manufacturer's Site Reports: Provide report of paint manufacturer's representative for each visit to Site by paint manufacturer's representative.
 - 5. Special Procedure Submittals:
 - a. Proposed protection procedures for each area of Work, explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption.
 - b. Site-specific health and safety plan.
 - c. Procedures for maintaining acceptable application, curing and environmental conditions during and after painting systems application.
 - d. Procedures for providing adequate lighting, ventilation, and personal protection equipment relative to painting Work.
 - 6. Qualifications:
 - a. Applicator.
 - b. Testing laboratory
- C. Closeout Submittals: Submit the following:
- 1. Maintenance Manual: Upon completion of the painting Work, furnish ENGINEER five copies of detailed maintenance manual including the following information:
 - a. Complete and updated product catalog of paint manufacturer's currently available products including complete technical information on each product. Identify product names and numbers of each product used in the painting Work.
 - b. Name, address, e-mail address and telephone number of manufacturer, local distributor, applicator and technical representative.
 - c. Detailed procedures for routine maintenance and cleaning.
 - d. Detailed procedures for light repairs such as dents, scratches and staining.
 - 2. Statement of Application: Upon completion of the painting Work, submit a notarized statement to ENGINEER signed by CONTRACTOR and painting applicator stating that Work complies with requirements of the Contract Documents and that application methods, equipment, and environmental conditions were proper and adequate for conditions of installation and use.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Product Delivery Requirements: Deliver products to Site in original, new, and unopened packages and containers, accurately and legibly and accurately labeled with the following:
- 1. Container contents, including name and generic description of product.

2. Manufacturer's stock number and date of manufacture.
 3. Manufacturer's name.
 4. Contents by volume, for major pigment and vehicle constituents.
 5. Grams per liter of volatile organic compounds.
 6. Thinning instructions, where recommended.
 7. Application instructions.
 8. Color name and number.
- B. Product Storage Requirements:
1. Store acceptable materials at Site.
 2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
 3. Store products that are not in actual use in tightly covered containers.
 4. Comply with health and fire regulations of authorities having jurisdiction at Site.
- C. Product Handling Requirements:
1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.
 2. Do not open containers or mix components until necessary preparatory work has been completed and approved by ENGINEER and painting Work will start immediately.
 3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.7 SITE CONDITIONS

- A. Site Facilities:
1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system applications, are not available at the Site.
 2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance, and temperature-monitoring personnel is CONTRACTOR's responsibility.
 3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent heat sources to exterior so that paint systems and personnel are unaffected by exhaust products.
- B. Existing Conditions:
1. Existing surfaces to receive painting Work shall have their surfaces prepared to meet requirements of painting systems specified. Prior to initiating painting Work, perform adhesion tests on existing surfaces to be painted. Perform testing per ASTM D4541 or other method acceptable to ENGINEER. Number and location of tests shall be sufficient to determine the condition of existing coatings and suitability of existing coatings to

- remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER the adhesion test results.
2. Provide abrasive blasting, scraping, or other abrading or surface film removal, or preparatory techniques accepted by ENGINEER.
 3. Before commencing painting in an area, surfaces to be painted and floors shall be cleaned of dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air (HEPA) filters and dust containment systems.
 4. After painting operations have started in a given area, cleaning only with commercial vacuum cleaning equipment with high-efficiency particulate air (HEPA) filters and dust containment systems.
- C. Environmental Requirements:
1. Comply with manufacturer's published requirements.
- D. Protection:
1. Cover or otherwise protect finished Work of other trades and those surfaces not being painted concurrently and not to be painted.
 2. During surface preparation and painting, facility shall remain in operation. Use procedures that prevent contamination of process or cause or require facility shutdown.
 3. Coordinate and schedule surface preparation and painting to avoid exposing personnel to hazards associated with painting Work. Provide required personnel safety equipment per requirements of authorities having jurisdiction at Site.
 4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work until ENGINEER accepts protection techniques proposed by CONTRACTOR.
 5. When working with flammable materials, provide fire extinguishers and post temporary signs warning against smoking and open flame.

PART 2 - PRODUCTS

2.1 PAINTING SYSTEM MANUFACTURERS

- A. Products and Manufacturers: Where referenced under painting systems, provide painting systems manufactured by the following:
1. Tnemec Company, Incorporated (TCI).
 2. The Carboline Company, part of StonCor Group, an RMP Company (TCC).
 3. Sherwin-Williams Company (SWC).
 4. Benjamin Moore & Company (BMC).
 5. ICI Paints (ICI).
 6. Or equal.

2.2 PAINTING SYSTEMS

A. New and Existing Cast-In-Place Concrete Associated With Wet Well and Influent Channels to be Covered; Non-submerged, Intermittently Submerged and Submerged, Interior and Exterior:

1. Provide painting system components specified for all cast-in-place concrete surfaces within the wet well and influent channels, beginning at elevation as shown on the Drawings and extending to top of horizontal walkway surface, including troughs, walls, beams, columns, undersides of walkways, and other locations that may be shown. Note that this Work is included as a Bid Alternate to the Contract.
2. Surface Preparation: Refer to Paragraphs 1.7.B., 3.2.A. and 3.2.B.
 - a. At locations where cementitious waterproofing skim coat is applied, provide abrasive blasted surface profile exposing underlying concrete surface. Refer to paragraph 3.2.B.
 - b. Confirm cementitious waterproofing skim coat was applied 30 days prior to surface preparation.
 - c. All concrete surfaces are to receive an abrasive blast or equivalent to remove laitance, form release agents, curing compounds, sealers and other contaminants and to provide a surface profile in accordance with SSPC-SP13/NACE 6, or ICRI CSP5.
3. Primer-Filler/Finish:
 - a. Generic Components:
 - 1) Primer - 100% solids (mixed) epoxy modified cementitious mortar - high-performance, aggregate reinforced material.
 - 2) First Coat - 100% solids (mixed), modified aliphatic amine epoxy mortar.
 - 3) Finish Coats – 100% solids (mixed), modified polyamine epoxy.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Primer: MortarClad Series 218, (TCI); Carboguard (TCC): (PPG PMC); One Coat, 60.0 to 62.0 dry mils, per coat.
 - 2) First Coat: Perma-Shield H2S Series 434 (TCI); Carboguard (TCC): (PPG PMC); One Coat, 125.0 dry mils, per coat.
 - 3) Finish Coats: Perma-Glaze Series 435 (TCI); Carboguard (TCC): (PPG PMC); One Coat, 15.0 to 20.0 dry mils, per coat.

B. New and Existing Concrete Unit Masonry Walls: Non-Submerged, Interior:

1. Surface Preparation: Refer to Paragraphs 1.7.B., 3.2.A., 3.2.B.
2. Primer and Filler:
 - a. Generic Components:
 - 1) Minimum 38 percent solids, vinyl acrylic block filler; 61 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Latex Block Filler M88 (BMC); Prep and Prime Block Filler 3010-1200 (ICI); PrepRite Block Filler B25W25 (SWC): One coat, 7.0 to 14.5 dry mils.
3. Primer:
 - a. Generic Components:

- 1) Minimum 30 percent solids, 100 percent acrylic; 91 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Eco Spec Interior Latex Primer Sealer 231 (BMC); Devflex 4020 PF (ICI); Harmony Low Odor Interior Latex Semi-Gloss (SWC): One coat, 0.8 dry mils.
 4. Finish: Semi-Gloss:
 - a. Generic Components:
 - 1) Minimum 34 percent solids, 100 percent acrylic latex, flat; 50 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Pristine Eco Spec Latex Enamel, 224 (BMC); Dulux Lifemaster 2000-9200 (ICI); Harmony Low Odor Interior Latex Semi-Gloss (SWC): Two coats, 1.4 dry mils.
- C. New and Existing Ferrous Metals, Structural Steel (With or Without Sprayed Fireproofing), Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, and Exterior Surfaces of All Ferrous Metal (Both Exposed and to be Later Covered With Insulation); Non-submerged, Interior:
1. Surface Preparation: Refer to Paragraphs 1.7.B., 3.2.A., 3.2.C.
 2. Shop Primer:
 - a. Generic Components:
 - 1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 4.0 to 6.0 dry mils.
 3. Field Primer and Touch-Up:
 - a. Generic Components:
 - 1) Minimum 100 percent volume solids, high-build, two-component, polyamide-catalyzed epoxy; 8 grams per gallon VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 165 Epoxoline 100 (TCI); Carboguard 954 HB (TCC); Cor-Cote HP (SWC): One coat, 8.0 to 12.0 dry mils.
 4. Finish: High-Gloss:
 - a. Generic Components:
 - 1) Minimum 80 percent volume solids, high-build, chemical-resistant, high-gloss, modified, polyamine- or polyamidoamine-catalyzed epoxy finish; 25 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 280 Tneme-Glaze (TCI); Carboguard 890 LT (TCC); Cor-Cote HP (SWC):
 - a) Horizontal Surfaces: One coat, 6.0 to 12.0 dry mils.
 - b) Vertical Surfaces: One coat, 4.0 to 8.0 dry mils.

- D. New and Existing Ferrous Metals, Non-Ferrous Metals and Exterior Surfaces of Piping; Submerged or Intermittently Submerged, including up to 4.0 above liquid surface; Interior and Exterior:
1. Surface Preparation: Refer to Paragraphs 1.7.B., 3.2.A., 3.2.C, and 3.2.D.
 2. Factory Primer:
 - a. Generic Components:
 - 1) Minimum 67 percent solids, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy; 334 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 4.0 dry mils.
 3. Shop Prime/Touch-Up/Finish, Satin:
 - a. Generic Components:
 - 1) Minimum 100 percent volume solids, high-build, two-component, polyamide-catalyzed epoxy or polyamido-amine epoxy; 10 grams per gallon VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 890 LT (TCC); Dura-Plate UHS (SWC): Three coats, 8.0 to 15.0 dry mils, per coat.
- E. New and Existing Aluminum in Contact with Dissimilar Materials:
1. Surface Preparation: Refer to Paragraphs 1.7.B., 3.2.A. and 3.2.D.
 2. Primer/Finish:
 - a. Generic Components:
 - 1) Minimum 100 percent volume solids, high-build, two-component, polyamido-amine or polyamine epoxy; 49 grams per gallon VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 165 Epoxoline 100 (TCI); Carboguard 954 HB (TCC); Dura-Plate UHS (SWC): Two coats, 8.0 to 15.0 dry mils, per coat.
- F. New and Existing Pipe and Duct Insulation, Cloth, Paper and Canvas Jacketed; Non-submerged, Interior:
1. Surface Preparation: Refer to Paragraphs 1.7.B, 3.2.A. and 3.2.E.
 2. Primer:
 - a. Generic Components:
 - 1) Minimum 38 percent volume solids single-component, self-cross linking acrylic primer-sealer; 159 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 115 Uni-Bond DF (TCI); Sanitile 120 (TCC); Pro-Cryl Universal Primer (SWC): One coat, 2.0 to 4.0 dry mils.
 3. Finish: Satin:
 - a. Generic Components:
 - 1) Minimum 37 percent volume solids, single component, self-cross linking acrylic; 226 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:

- 1) Series 116 Uni-Bond (TCI); Carbocrylic 3358 (TCC); Pro-Cryl Universal Primer (SWC): One coat, 2.0 to 4.0 dry mils.

- G. New and Existing Exterior Surfaces of Ductile Iron Process Pipe; Buried Exterior:
1. Refer to Section 40 05 19, Ductile Iron Process Pipe.

- H. New and Existing Gypsum Wallboard, Plaster and Wood; Interior:

1. Surface Preparation: Refer to Paragraphs 1.7.B., 3.2.A. and 3.2.F.
2. Gypsum Wallboard, Plaster, and Wood Primer:
 - a. Generic Components:
 - 1) Minimum 17 percent solids, 100 percent waterborne modified polyamine epoxy or cross-linked water-based acrylic-epoxy; 170 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 151 Elasto-Grip FC (TCI); Sanitile 255 (TCC); 3478 Epoxy Primer/Sealer (SWC): One coat, 0.7 to 1.5 dry mils.
3. Gypsum Wallboard, Plaster, and Wood Finish:
 - a. Generic Components:
 - 1) Minimum 44 percent solids, waterborne acrylic epoxy or water-based epoxy; 250 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 113/114 HB Tneme-Tufcoat (TCI); Sanitile 555 (TCC); 3479 High Performance Epoxy Coating (SWC): Two coats, 4.0 to 6.0 dry mils, per coat.

2.3 CALKING AND SEALANTS

- A. Refer to Section 07 92 00, Joint Sealants.

2.4 INSTRUMENTS

- A. Instruments:
1. Provide one new dry-film thickness gauge for checking film thickness, one holiday detector to detect holidays or holes in the coating, and one set of visual standards to check surface preparation. Calibrate dry film thickness gauge at Site using Bureau of Standards standard shim blocks.
 2. Products and Manufacturers: Provide the following:
 - a. Film Thickness Testers: Model FM-III manufactured by Mikrotest, or equal.
 - b. Holiday detector shall be Model M-1 as manufactured by Tinker & Razor, or equal.
 - c. Visual Standards: ASTM D2200, Swedish Standards, SSPC VIS 1.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which painting Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for long-term adherence and durability of painting systems specified, or where paint manufacturer requires removal of all existing paint to recommend use of specified painting system.

3.2 SURFACE PREPARATION

- A. General:
 - 1. Test for moisture content of surfaces before commencement of painting Work. Test for moisture in concrete in compliance with ASTM D4263. Report results to ENGINEER before commencing Work.
 - 2. Perform preparation and cleaning procedures as specified herein and in strict accordance with paint manufacturer's approved instructions for each surface and atmospheric condition.
 - 3. CONTRACTOR shall provide effective surface-applied protection for in place items that do not require painting prior to surface preparation and painting operations.
 - 4. CONTRACTOR shall remove as necessary items that must be field-painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved.
 - 5. Clean surfaces to be painted before applying painting system components. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning.
 - 6. Prepare surfaces that were improperly shop-painted and abraded or rusted shop-painted surfaces as specified.
- B. Cast-In-Place Concrete, Precast Concrete and Masonry Surfaces:
 - 1. Prepare surfaces of concrete unit masonry to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and other contamination using soap and water. Surfaces shall be clean and dry at time of paint system application.
 - 2. Concrete unit masonry that cannot be adequately cleaned using soap and water shall be acid etched with a commercial solution of 15 percent muriatic acid.
 - 3. Prepare and clean cast-in-place concrete and precast concrete surfaces per ASTM D4259 to provide a uniform and continuous anchor profile of approximately one mil. Provide mechanical abrading and abrasive blasting per ASTM D4259. Use 40 to 80-mesh abrasive and clean, dry, compressed air. Compressed air cleanliness shall be per ASTM D4285. Pressure at blasting nozzle shall not exceed 80 pounds per square inch. Do not

concentrate blast on surface; instead, move at a fairly rapid rate to provide a surface free of laitants and contaminants. Provide post-surface preparation cleaning per ASTM D4258 to remove loose material. Surface preparation shall open all surface air holes by removing laitance shoulders surrounding air holes. Vacuum surfaces to remove dust and sand, and wash with potable water.

4. Where paint system is for chemical containment barrier protection, repair cracks and expansion joints in concrete and provide 2-inch radiused cove base fillets at equipment pads and containment walls as part of complete chemical containment paint system Work. Use materials and techniques recommended by manufacturers of the paint and concrete repair products.
5. Remove from cast-in-place concrete fins, projections, and other surface irregularities that would protrude above level of finished intermediate fillers and surfacers. Remove by chipping and scarification by mechanical abrasion.
6. Using specified filler and surfacer, patch cast-in-place concrete and precast concrete surfaces as required to completely fill surface air holes and honeycombing. Level all protrusions, grind filler and surfacing compounds smooth, and level with adjacent surfaces.
7. Perform tests per ASTM D4262 and ASTM D4263 to verify alkalinity and moisture content of surfaces to be painted, and report findings to ENGINEER. If, in ENGINEER's opinion, surfaces are sufficiently alkaline to cause blistering and burning of paint, correct the condition before applying paint. Provide suitable testing materials for alkalinity and moisture tests. Do not paint surfaces where the moisture content exceeds eight percent.
8. Where a concrete unit masonry block filler is specified, spot patch holes and cracks with a putty knife using specified block filler. Apply to large surfaces by airless spray and backroll uniformly using a roller with a synthetic nap cover. Follow with a rubber squeegee to provide a smooth finish.

C. Ferrous Metals:

1. Ferrous Metals except Ductile and Cast Iron:
 - a. Comply with paint manufacturer's recommendations for type and size of abrasive to provide a surface profile that meets manufacturer's painting system requirements for type, function, and location of surface. Verify that paint manufacturer-recommended profiles have been achieved on prepared surfaces. Report profiles to ENGINEER using Test Method C of ASTM D4417.
 - b. Clean non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed, of all oil, grease, dirt, mill scale, and other contamination by commercial blast cleaning complying with SSPC SP 6 at time of paint system application, using SSPC VIS 1 as a standard of comparison.
 - c. Clean submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed of all oil, grease, dirt, mill

- scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.
- d. Clean non-submerged, ferrous surfaces that have not been shop-coated of all oil, grease, dirt, loose mill scale, and other contamination by commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison.
 - e. Clean submerged ferrous surfaces that have not been shop-coated or that have been improperly shop-coated of all oil, grease, dirt, mill scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.
 - f. Touch-up shop-applied prime coats that have damaged or have bare areas with primer recommended by paint manufacturer after commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison, to provide a surface profile of not less than one mil.
 - g. Power tool-clean per SSPC SP 3 to remove welding splatter and slag.
- D. Non-Ferrous Metal Surfaces: Prepare non-ferrous metal surfaces for painting by light whip blasting or by lightly sanding with 60- to 80-mesh sandpaper.
- E. Covering on Pipe Insulation:
- 1. Remove all oil and surface contaminants as recommended by paint and insulation cover manufacturer for surface and application required.
 - 2. Do not cut or damage insulation and covering.
- F. Gypsum Wallboard, and Plaster:
- 1. Patch, sand, and seal rough spots before applying prime coat. Remove all dust and other contaminants prior to painting.
 - 2. Touch-up suction spots and hot spots with primer before applying finish coats.

3.3 PROTECTION OF PROPERTY AND STRUCTURES

- A. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation, and painting Work.
- B. Use shrouding, vacuum blasting, or other acceptable methods for cleaning and surface preparation of exterior surfaces.
- C. During blast cleaning and surface preparation of interior and exterior surfaces, control exhausting of dust and grit using shrouding, negative-pressure containment/dust collection systems, or other means to protect adjacent property and structures and prevent dust and grit from escaping. Similarly, control removal and temporarily store residues to protect adjacent property and structures.

- D. For painting of exterior surfaces, use rollers, shrouding, or other acceptable methods as required to protect adjacent property and structures from wind-blown paint residues.
- E. Submit proposed procedures for cleaning, surface preparation, and paint application that describe in detail methods to be used to protect adjacent property and structures from residues. Do not proceed with cleaning, surface preparation, or painting until proposed procedures are accepted by ENGINEER.

3.4 MATERIALS PREPARATION

- A. General: Mix and prepare painting products in strict accordance with paint manufacturer's product data sheets.

3.5 APPLICATION

- A. General:
 - 1. Apply paint systems by brush, roller, or airless spray per paint manufacturer's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Volume 2, where applicable, and in strict accordance with paint manufacturer's product data sheets.
 - 2. Surfaces of items not normally exposed-to-view do not require same color as other components of system of which they are a part, but require same painting system specified for exposed surfaces of system.
 - 3. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.
 - 4. Paint backs of access panels and removable or hinged covers to match exposed surfaces.
 - 5. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint to shop-primed coats and pre-finished items only when approved by ENGINEER using compatible primers and paint manufacturer's recommended compatible field-applied finishes.
 - 6. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.
- B. Minimum/Maximum Paint Film Thickness: Comply with manufacturer's published recommendations for coating type and surface.
- C. Scheduling Surface Preparation and Painting: Comply with manufacturer's published recommendations for coating type and surface.
- D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to result in a finish coat with no burn-through or other defects caused by insufficient sealing.

- E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.
- F. Brush Application:
 - 1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
 - 2. Brush-apply all primer or first coats, unless otherwise allowed to use mechanical applicators.
- G. Mechanical Applicators:
 - 1. Use mechanical methods for applying paint when allowed by applicable ordinances, paint manufacturer, and approved by ENGINEER.
 - 2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide equivalent hiding as brush-applied coats.
 - 3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of two coats in one pass.
- H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

3.6 FIELD QUALITY CONTROL

- A. ENGINEER reserves right to invoke the following product testing procedure at any time, to a maximum of five times, during field painting Work:
 - 1. CONTRACTOR shall engage service of an independent testing laboratory to sample paints used. Samples of materials delivered to Site shall be taken, identified, and sealed, and certified as to being the material actually applied to surfaces in each area, in presence of CONTRACTOR.
 - 2. A testing laboratory selected by OWNER and paid by CONTRACTOR at no extra cost to OWNER will perform appropriate tests for any or all of the following characteristics:
 - a. Abrasion resistance.
 - b. Apparent reflectivity.
 - c. Flexibility.
 - d. Washability.
 - e. Absorption.
 - f. Accelerated weathering.
 - g. Dry opacity.
 - h. Accelerated yellowness.
 - i. Recoating.
 - j. Skinning.
 - k. Color retention.

- l. Alkali resistance.
 - m. Quantitative materials analysis.
- 3. If test results show that product being used does not comply with specified requirements, CONTRACTOR may be directed to stop painting and remove non-complying paint; and prepare and repaint surfaces painted with rejected paint with products complying with the Contract Documents.
- B. Notify ENGINEER after completing each coat of paint. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by ENGINEER, proceed with succeeding coat. Perform testing using testing instruments specified in Article 2.4 of this Section.
- C. For magnetic substrates, measure thickness of dry film nonmagnetic coatings following recommendations of SSPC PA-2. These procedures supplement manufacturers' approved instructions for manual operation of measurement gauges and do not replace such instructions.
- D. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit testing results to ENGINEER.

3.7 PROTECTION

- A. Provide "Wet Paint" signs as required to protect newly painted finishes. After completing painting Work, remove temporary protective wrappings provided for protection of the Work and work of other contractors.

3.8 ADJUSTMENT AND CLEAN-UP

- A. Correct damage to work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.
- B. During progress of the Work, remove from Site all discarded paint products, rubbish, cans, and rags at end of each workday.
- C. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
- D. At completion of Work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by ENGINEER.

3.9 WASTE MANAGEMENT

- A. Refer to Section 01 74 05, Cleaning.

3.10 SCHEDULES

- A. The schedules listed below, following the “End of Section” designation, are a part of this Specification section.
1. Table 09 91 00-A, Painting Schedule.

**TABLE 09 91 00-A
PAINTING SCHEDULE**

Facility or Surface *	Room No.	Painting System **	Remarks
New and Existing Concrete at Wet Well and Influent Channels	Wet Well 01	A	See Typical Protective Coating Detail on ‘S’ Drawings. This Work is part of a Bid Alternate to the Contract. Refer to Specification 01 22 13.
All New and Existing CMU walls		B	Entire First Floor at elevation 76.80.
New and Existing Ferrous Metals, Structural Steel (With or Without Sprayed Fireproofing), Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, and Exterior Surfaces of All Ferrous Metal (Both Exposed and to be Later Covered With Insulation); Non-submerged, Interior		C	
New and Existing Ferrous Metals, Non-Ferrous Metals and Exterior Surfaces of Piping; Submerged or Intermittently Submerged, including up to 4.0 above liquid surface; Interior and Exterior		D	
All New Aluminum in Contact with Dissimilar Materials		E	Includes any Existing Aluminum that is relocated or temporarily removed and then re-installed as part of the Work.
New and Existing Pipe and Duct Insulation, Cloth, Paper and Canvas Jacketed; Non-submerged, Interior		F	
New and Existing Exterior Surfaces of Ductile Iron		G	

Process Pipe; Buried Exterior			
New and Existing Gypsum Wallboard, Plaster and Wood; Interior		H	

* Refer to Drawings for facility locations and for facilities not listed above.

** Refer to Article 2.2 of this Section.

+ + END OF SECTION + +

++NO TEXT ON THIS PAGE++

SECTION 10 14 00

SIGNAGE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install signage.
2. Extent of signage is shown and specified.
3. Types of products required include the following:
 - a. Photo-luminescent exit signs.
 - b. Room identification, information, entry and directional signs.
 - c. Health, safety, warning, floor loading and fire extinguisher location signs.
 - d. Pipe markers, tags, and equipment nameplates.
 - e. Right-to-know labels, signs and tags.
 - h. Site entry, directional and information signs.
 - j. Stainless steel fasteners, supports, very-high-bond high-performance mounting tape, primers and other accessories.

B. Coordination:

1. Coordinate adhesives and fasteners with mounting surfaces. Review other Sections to ensure compatibility of signage mounting accessories with various surfaces on which signage will be installed.
2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before signage Work.

C. Related Sections:

1. Section 03 30 05, Concrete.
2. Section 09 91 00, Painting.
3. Section 31 20 00, Earth Moving.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AA DSA-45, Designation System for Aluminum Finishes.
2. ASME A13.1 Scheme for the Identification of Piping Systems.
3. ANSI/ICC A117.1, Accessible and Usable Buildings and Facilities.
4. ANSI Z535.1, Marking Physical Hazards Safety Color Code.
5. ANSI Z535.2, Environmental and Facility Safety Signs.
6. ANSI Z535.3, Criteria for Safety Symbols.
7. ASTM B26/B26M, Specification for Aluminum-Alloy Sand Castings.

8. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
9. ASTM E527, Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS).
10. CDA, Properties of Cast Copper Alloys.
11. NFPA 704, System for the Identification of the Hazards of Materials for Emergency Response.
12. UL 924, Safety of Emergency Lighting and Power Equipment.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 1. Signage Manufacturers:
 - a. Engage firms specializing in producing types of products specified, in compliance with the Contract Documents, with documented record of successful in-service performance, and that possess sufficient production capacity to avoid delaying the Work.
 - b. Submit to ENGINEER name and experience record of manufacturers.
- B. Component Supply and Compatibility:
 1. Obtain each separate type of signage from a single Supplier and from a single manufacturer.
- C. Regulatory Requirements: Comply with applicable requirements of the following:
 1. OSHA, 29 CFR Part 1910.1200, Hazard Communication Standard.
 2. OSHA, 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances.
 3. OSHA, 29 CFR Part 1910.144, Safety Color Code for Marking Physical Hazards.
 4. OSHA, 29 CFR Part 1910. 145, Specification for Accident Prevention Signs and Tags.
 5. United States Access Board, Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines.
 6. Americans with Disabilities Act (ADA), Public Law 101-36, 28 CFR Part 36, Appendix A, Accessibility Guidelines for Buildings and Facilities (ADAAG), relative to characters and symbols contrast only.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Schedule of all signage required for the Work, indicating signage type location, and other information to demonstrate compliance with the Contract Documents.
 - b. Fabrication and erection information for each type of signage
 - c. Valve schedule for small-diameter valves, in accordance with this Section.

- d. Complete, camera-ready, color graphic layouts of custom- designed signs based on specified requirements and manufacturer recommendations.
- e. Complete selection of each specified manufacturer's standard and custom graphic layouts and pictograms, colors, and alphabetic/text styles.
- f. Full-size graphic layout drawings for plaques, individual dimensional letters and numbers, and other items where final graphic appearance is necessary prior to signage fabrication, incorporating all required graphic features specified or shown.
- g. Mounting and Installation Data:
 - 1) Drawings of and information on anchorages and accessory items.
 - 2) Submit location template drawings for items supported or anchored to permanent construction.
 - 3) Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on plan drawings showing locations of required exit signs based on measurements taken at the Site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for non-interference with other Work and as required by authorities having jurisdiction.
- 2. Product Data:
 - a. Copies of manufacturer's technical data, including catalog information and specifications, for each product specified.
- 3. Samples:
 - a. Each color and finish of exposed materials and accessories required for signage.
 - b. Sample Signage:
 - 1) Full-size Sample of each type of permanent room and space identification sign, and informational and directional sign incorporating all features specified.
 - 2) Full-sized Sample of each type (such as snap-on, strap-on, and adhesive) of pipe marker proposed for use with mounting accessories.
 - 3) Full-sized Sample equipment nameplate, valve tag, pipe tag, and accessories. Stamp valve tag with information shown on valve schedules. When not indicated in the Contract Documents, information on the type of coding system will be furnished to CONTRACTOR by ENGINEER.
 - 4) Full-sized Sample right-to-know signs, labels and tags.
 - 5) Full-size representative sample of each individual-type letter and number specified, demonstrating alphabetic style/text type, material, color and finish specified.
 - c. ENGINEER's review of Samples will be for color and texture only. Compliance with other requirements is CONTRACTOR's responsibility.

- B. Informational Submittals: Submit the following:
 - 1. Manufacturer's Instructions:
 - a. Templates for anchorages to be installed in concrete or masonry.
 - b. Manufacturer's instructions and recommendations for support and foundations of signs installed outdoors.
- C. Closeout Submittals: Submit the following:
 - 1. Warranty Documentation:
 - a. General and special warranties required under this Section.
- D. Maintenance Material Submittals: Submit the following:
 - 1. Extra Stock Materials:
 - a. Furnish extra stock materials from the same manufactured lot as the materials installed.
 - b. Submit documentation of actual quantities of signage installed for the Project and calculations indicating the required quantity of extra stock materials.
 - c. Furnish the following spare parts and accessories:
 - 1) For every 20 of each type (snap-on, strap-on, adhesive type) of pipe markers installed:
 - a) One complete mounting assembly.
 - 2) For every 20 equipment nameplates installed:
 - a) One complete nameplate mounting assembly.
 - 3) For every 20 valve tags and pipe tags installed:
 - a) One stainless steel cable and splice.

1.5 WARRANTY

- A. General Warranty: The special warranty specified for each type of sign in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty on Products:
 - 1. Provide each signage manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials specified in this Section found to be defective during a period of five years after the date of Substantial Completion.
 - 2. Special warranty shall cover defective Work that includes, but is not limited to, the following:
 - a. Deterioration of metal and polymer finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image colors and sign lamination.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:

1. Details shown or indicated for signage, such as alpha-numeric and text type representation, letter spacing, designs of borders, and other graphic features, are generic and intended only to establish text, general positions, and symbols.
2. Colors shall be brilliant, distinctive shades, matching the safety colors specified in ANSI Z535.1 and OSHA 1910.144.
3. Permanent rooms and spaces, and directional and informational signage where specified as accessible to people with disabilities, shall comply with ANSI/ICC A117.1 and ADA-ABA Accessibility Guidelines.
4. Accident prevention signs and tags shall comply with OSHA 1910.145.
5. Health, safety, and warning signs shall comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, OSHA 1910.144, and 1910.145, unless otherwise shown or indicated. Colors shall be as indicated in Table 1 of ANSI Z535.1. In addition to text, safety symbol pictograms shall be incorporated into each sign.

2.2 PHOTO-LUMINESCENT EXIT SIGNS

A. Products and Manufacturers: Provide one of the following:

1. Series 90.8924 Photoluminescent Exit Signs by EverGlow NA, Inc.
2. Series 2002 by Active Safety Corporation.
3. Or equal.

B. Photo-luminescent Exit Signs:

1. Provide photo-luminescent exit signs with single- and double-face dimensions of nine inches by 14.25 inches by 3/4-inch deep.
2. Sign housing shall consist of an AA-A42 color anodized extruded aluminum frame and legend protected by a temper-resistant polycarbonate shield.
3. Size, graphics, and background colors of sign legend shall comply with Laws and Regulations.
4. Sign Letters and Directional Arrows. Furnish signs with photo-luminescent luminous letters and directional arrows.
5. Signs shall comply with UL 924 and be constructed for 15-year service life each.
6. Rated Viewing Distance: 75 feet.
7. Provide manufacturer's standard universal mounting brackets, extended wall and ceiling mounting brackets, pendant mounting brackets, and recessed mounting brackets as required by mounting surface and exiting conditions, or as shown.

2.3 PANEL SIGNS – ROOM IDENTIFICATION, INFORMATION, ENTRY, AND DIRECTIONAL

- A. Products and Manufacturers: Provide one of the following:
 - 1. Graphic Blast MP and FG ADA System and Custom Design ADA Series, by Best Sign Systems, Inc.
 - 2. Blast Etched Fiberglass and Blast Etched Melamine Signs, by **Visigraph** Corporation.
 - 3. Or equal.
- B. Panel Signs – Room Identification, Information, Entry, and Directional:
 - 1. Product Description: Provide unframed signs, surface-etched, 1/32-inch raised tactile lettering and pictograms, sandblasted on an opaque sheet.
 - 2. Materials:
 - a. Interior Signs: Three-ply, self-extinguishing melamine plastic.
 - b. Exterior Signs: One-piece fiberglass.
 - 3. Size and Thickness: 0.125-inch thick; eight inches by eight inches with 1/2-inch radiused corners.
 - 4. Graphics and Text: White, Standard Helvetica Medium characters and matching arrow type-face; upper and lower case letters, one-inch high capitals and, in addition, Grade 2 Braille alphabet for room designation, directional, entry, and information signs.
 - 5. Colors and Contrast: Background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast by at least 70 percent with their background as determined by ADA formula in ADAAG Appendix A4.30.5.

2.4 PANEL SIGNS – HEALTH, SAFETY, WARNING, FLOOR LOADING, AND FIRE EXTINGUISHER LOCATION

- A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.
- B. Products and Manufacturers: Provide one of the following:
 - 1. Graphic Blast Word and Picture Series, by Best Sign Systems, Inc.
 - 2. Blast Etched Fiberglass Signs, by Visigraph Corporation.
 - 3. Or equal.
- C. General:
 - 1. Size and Thickness: 0.125-inch thick; 10 inches by 14 inches, unless otherwise shown or indicated.
 - 2. Graphics and Text: Standard Helvetica Medium characters and matching arrow type-face; upper and lower case, one-inch high capitals and, in addition, Grade 2 Braille alphabet message designations and other text.

3. Exposure: As recommended by sign manufacturer for both indoor and outdoor use and with an upper service temperature limit of 190degrees F. Average durability for outdoor use shall be 15 years.
- D. Safety Instruction Signs: Standard color of sign background shall be white; panel shall be green with white letters and numbers. Letters and numbers used against white background shall be black.
- E. Caution Signs: Standard color of sign background shall be yellow; panel shall be black with yellow letters and numbers.
- F. Danger Signs: Standard color of sign background shall be white; panel shall be black with red insert with white letters and numbers. Letters and numbers used against white background shall be black.
- G. Warning Signs: Standard color of sign background shall be orange; panel shall be black with orange insert with black letters and numbers. Letters and numbers used against orange background shall be black.
- H. No Smoking Signs: Standard color of sign background shall be white. Letters and numbers used against white background shall be red.
- I. Biohazard Signs: Standard color of sign background shall be white; panel shall be black with white letters. Sign shall include red international biohazard pictogram on white background.
- J. Floor Loading Signs: Standard color of sign background shall be white; panel shall be blue with white letters and numbers. Letters and numbers used against white background shall be black.
- K. Fire Extinguisher Location Signs (surface-mounted units only): Standard color of sign background shall be red with white letters and numbers. Each sign shall include international fire extinguisher pictogram and directional arrow indicating location of fire extinguisher.
- L. Auxiliary Products:
 1. Mounting Brackets: Provide sign manufacturer's standard mounting brackets for installing projected or double-sided signs.

2.5 PIPE MARKERS

- A. Description:
 1. Provide pipe markers for each pipeline provided under the Contract, and for other piping indicated to receive pipe markers.
- B. Products and Manufacturers: Provide one of the following:

1. Custom High Performance Pipe Markers (B-689), and SnapOn and StrapOn Pipe Markers (B-915), by Brady Worldwide, Inc., Signmark Division.
2. Custom Ultra-Mark High Performance Pipe Markers, by Seton Identification Products, a Tricor Direct Company.
3. Or equal.

C. Pipe Markers:

1. Lettering of Titles/Legend and Color Field Size:
 - a. Letter size and color field length shall be as indicated in Table 10 14 00-A of this Section:

**TABLE 10 14 00-A, PIPE MARKERS:
SIZE OF TEXT AND COLOR FIELD**

Outside Diameter of Pipeline or Covering* (inches)	Size of Text (Legend Characters)	Minimum Length of Color Field**
3/4 to 1.25	1/2-inch	8 inches
1.5 to 1-7/8	3/4-inch	8 inches
2 to 5-7/8	1.25-inch	12 inches
6 to 9-7/8	2.5-inch	24 inches
10 and Larger	3.5-inch	32 inches
*Outside diameter includes pipe diameter plus insulation and jacketing. **Length of sign and color field shall be as required to accommodate required legend, and shall not be less than minimum length indicated unless required otherwise by space constraints.		

- b. Text and symbols shall be Standard Helvetica Medium, all upper case. Pipe markers shall include text with separate arrow signs indicating direction of flow of pipeline contents. Pipe markers with arrows shall be located as specified in Part 3 of this Section.
 - c. Pipe markers indicating pipeline contents shall identify pipeline contents by complete name, with color coding as approved by the ENGINEER.
 2. Pipe Marker Materials:
 - a. General: The following are applicable to all types of pipe markers furnished under this Section:
 - 1) Provide pipe markers with ultraviolet light-resistant, sealed, subsurface color graphics, recommended by sign manufacturer, suitable for both indoor and outdoor use.
 - 2) Pipe markers shall be resistant to abrasion, chemical reagents, and physical agitation such as washdowns and wind.
 - 3) Provide manufacturer's full selection of standard and custom sizes and graphics.
 - 4) Where manufacturer has established minimum order quantities for custom units provide minimum order quantities at no additional cost to OWNER.

- b. Materials: Provide the following at CONTRACTOR's option, suitable for outside diameter of the associated pipe and pipe covering:
 - 1) Adhesive, Wrap-Around Pipe Markers: Adhesive pipe markers shall be coiled construction, 0.006-inch total thickness, PVF over laminated polyester, with peel-off backing. Suitable for service temperature ranging from -40 degrees F to 230 degrees F.
 - 2) Snap-on Pipe Markers: Snap-on pipe markers shall be cylindrically coiled, printed plastic sheets. Pipe marker total thickness for pipe and pipe covering from 3/4-inch to 2-3/8-inch outside diameter shall be not less than 0.020-inch. Pipe marker total thickness for pipe and pipe covering from 2.5-inch through six-inch outside diameter shall be not less than 0.030-inch. Suitable for service temperature ranging from -40 degrees F to 180 degrees F.
 - 3) Strap-on Pipe Markers: Provide strap-on pipe markers where pipe diameter is large enough to preclude overlap of pipe marker material around the circumference of the pipe. Strap-on pipe markers shall be flat, printed plastic sheets, not less than 0.020-inch total thickness, constructed to be attached to the pipe with bands. Suitable for service temperature ranging from -40 degrees F to 180 degrees F. Provide each pipe marker with two 1/4-inch wide band straps of nylon, plastic, or stainless steel, lengths as required by circumference of pipe and pipe covering. Provide manufacturer's recommended banding tools for banding.
- 3. Legend for Pipe Markers: Pipe markers shall have the text or abbreviations in the color combinations to match existing or as approved by the ENGINEER. Pipe marker colors shall comply with ASME A13.1, unless otherwise indicated.

2.6 EQUIPMENT NAMEPLATES

A. Description:

- 1. Provide equipment nameplate for each equipment item furnished under the Contract, and for other equipment items indicated to receive nameplates. Equipment nameplates specified in this Article are in addition to equipment manufacturer's standard nameplate with manufacturer name, model number, serial number, and similar information.
- 2. Install equipment nameplates as indicated in Part 3 of this Section. Mechanically fasten equipment nameplates to the associated equipment item.

B. Products and Manufacturers: Provide one of the following:

- 1. Stainless Steel (HEET) Tags (B-748) custom engraved, by Brady Worldwide, Inc.
- 2. Custom Engraved Stainless Steel Nameplates, by Seton Identification Products, a Tricor Direct Company
- 3. Or equal.

C. Equipment Nameplates:

1. Material: Type 304 or Type 316 stainless steel, 26-gage, with rounded corners. Suitable for temperatures ranging from -40 to 89 degrees C.
2. Provide each equipment nameplate with not less than two holes, each approximately 3/16-inch diameter, for mechanically fastening nameplate to the associated equipment. Provide appropriate stainless steel fasteners.
3. Nameplate Size:
 - a. Size shall be as required for required text, and shall be not less than one-inch by four inches.
4. Text Engraved on Nameplates:
 - a. Text Size: Equipment nameplate titles shall have text as large as possible to fit on nameplate; text shall be not less than 1/2-inch high. All text on a given nameplate shall be one size.
 - b. Text and symbols shall be Standard Helvetica Medium, all upper-case.
 - c. Left-justify multiple lines of text
 - d. Where more than one item of the same type of equipment is furnished, consecutively number each associated equipment nameplates as shown or indicated; for example "Pump No. 1", "Pump No. 2", "Pump No. 3", and so on.
5. Legend for Nameplates:
 - a. Nameplates for equipment, including operating stands for valves and gates, shall be as approved by the ENGINEER.

D. Operating Stands for Valves and Gates:

1. Nameplate material, size, and text requirements are the same as indicated above for other equipment nameplates.
2. Operating stands for valves and gates shall carry the respective legends "V. No. ____" or "S.G. No. ____," with the appropriate equipment number to be indicated by ENGINEER.
3. Background and text color of nameplates for valve and gate operators shall be the same colors specified above for other equipment nameplates.

2.7 VALVE AND PIPELINE TAGS

A. Products and Manufacturers: Provide one of the following:

1. Custom Engraved Stainless Steel Valve Tags, by Brady Worldwide, Inc.
2. Custom Stainless Steel Valve Tags, by Seton Identification Products, a Tricor Direct Company
3. Or equal.

B. Metal Tags:

1. For each valve and for pipelines smaller than 3/4-inch outside diameter, provide permanently-legible, round metal tags, each two-inch diameter, Type 304 or Type 316 stainless steel, with engraved lettering filled with

black enamel. Provide tags with 3/16-inch diameter hole located that does not interfere with legend.

2. Legend for Valve Tags:
 - a. Based on information provided on the Drawings, submit to ENGINEER not less than thirty days before system startup, a valve schedule indicating all required valves.
 - b. For each valve, the valve schedule shall indicate: location, valve type, valve number, words to identify valve's function, type of operator, and normal operating position.
 - c. Information presented in the valve schedules shall be coded on tags in a system provided by or acceptable to OWNER. Each valve shall be coded and identified by ENGINEER utilizing a combination of up to twelve letters and numbers.
3. Legend for Small Pipeline Tags: Comply with requirements for pipe markers relative to legend. Where legend is not indicated, obtain interpretation from ENGINEER.
4. Miscellaneous Valve and Small Pipeline Tag Accessories:
 - a. Stainless Steel Wire: Nylon-coated; 0.048-inch outside diameter.
 - b. Clamps: Brass.
 - c. Lead Seals: Monel; four ply, 0.014-inch by 10 inches long; for attaching tags.
 - d. Hand Sealing Press: As recommended by tag manufacturer for crimping lead seals.

2.8 PANEL SIGNS – RIGHT-TO-KNOW LABELS, SIGNS, AND TAGS

- A. Products and Manufacturers: Provide one of the following:
 1. Custom B-302 Pressure Sensitive Polyester Right-To-Know Labels, B-120 Fiberglass Chemical Tank Signs, Front No. 1/Back No. 1 B-851 Right-To-Know Accident Prevention Tags and Right-To-Know Pictograms, by Brady Worldwide, Inc.
 2. Right-to-Know & HazCom Signs, Labels, and Tags, by Seton Identification Products, a Tricor Direct Company.
 3. Or equal.
- B. General:
 1. Right-to-know signs, labels, and tags shall use NFPA 704 “diamond” hazard identification systems and shall comply with OSHA 1910.1200 and OSHA Subpart Z.
- C. Tank Signs:
 1. Provide quantity of signs shown or indicated, identifying the chemical stored in the tank, chemical's hazards, required protective equipment in text and pictograms, first-aid for eyes, skin, ingestion and inhalation, information on confined space entry and NFPA 704-required hazard rating system information.

2. Right-to-know fiberglass signs for storage tanks shall have pressure-sensitive adhesive backs and be provided with subsurface numbers, symbols, text, and legends. Labels shall indicate chemical name and chemical abstracts service number, fire and health hazard potential, reactivity, personal protection and target organ legends in compliance with NFPA 704 format and OSHA 1910.1200.
- D. Labels: Provide right-to-know polyester labels for each hazardous chemical container. Provide labels seven inches by ten inches with information pre-printed by manufacturer. Provide labels with two-mil polyester overlamine and with a complete line of all standard and custom pictograms.
- E. Tags: Provide 15-mil right-to-know vinyl tags with self-adhering clear polyester overlamine. Tags shall be laminated plastic and provided with nylon tie fasteners. Provide tags three inches by 5.75 inches with two chamfered corners with reinforced 3/16-inch diameter grommeted hole.

2.9 PANEL SIGNS – SITE ENTRY, DIRECTIONAL, AND INFORMATION

- A. Products and Manufactures: Provide one of the following:
1. Series 820 Post and Panel Signs, by ASI Sign Systems, Inc.
 2. Custom Post and Panel Signs, by Andco Industries Corporation.
 3. Or equal.
- B. Fiberglass sheets, not less than 1/8-inch thick, bonded to extruded aluminum internal structure, to form a seamless monolithic sign panel. Provide the following:
1. Posts: Four-inch diameter, 6063-T52 alloy extruded aluminum posts, notched to receive sign panel. Provide posts to height of six feet above finished grade and extending below ground to extent shown or indicated.
 2. Finish: Two coats of colored polyurethane and one coat of clear polyurethane; factory-applied to posts and sign panels. Provide complete selection of manufacturer's standard and custom colors.
 3. Graphics: Subsurface, photo-mechanically incorporated utilizing an integral graphic process.
 4. Color: ENGINEER will select maximum of three colors, in addition to white and black. All colors and OWNER logo, in addition to white and black, will appear on each sign.
 5. Letter Style: Helvetica with matching directional arrows.

2.10 AUXILIARY MATERIALS

- A. Very-High-Bond High-Performance Bonding Tape:
1. Provide all surface-mounted signage with very-high-bond foam tape backing except where specified as requiring mechanical fasteners.
 2. Products and Manufacturers: Provide one of the following:

- a. Scotch Brand (Very-High-Bond) 4942 VHB Double Coated Acrylic Foam Tape and No. 94 Acrylic Primer, by 3M Industrial Tape and Specialties Division.
 - b. Or equal.
 3. Provide a very-high-bonding pressure sensitive joining system consisting of double-coated conformable acrylic foam tape and release liners.
 4. Thickness: 0.045-inch.
 5. Tape Width: 1.5 inches.
 6. Color: Dark gray.
 7. Bonding Adhesive: Acrylic; very-high-bond, solvent and shear resistance.
 8. Primer: High-performance tape manufacturers recommended acrylic primer.
- B. Fasteners: Provide fasteners of non-magnetic stainless steel of size and type required and recommended by the associated individual signage manufacturer.
- C. Anchors and Inserts: Provide nonferrous metal or hot-dipped galvanized anchors and inserts. Provide toothed stainless steel or lead expansion bolts for drilled-in-place anchors.
- D. Mounting Brackets:
1. Provide manufacturer's standard mounting brackets for each of the following sign types: hanging, projected, double-sided.
 2. Provide inserts, and mechanical and adhesive anchoring devices as specified in this Article for installation of signage.

2.11 FABRICATION

- A. Shop Assembly:
1. Fabricate and preassemble items in the shop to the greatest extent possible.
 2. Disassemble units only to extent necessary for shipping and handling limitations.
 3. Clearly mark units for reassembly and coordinated installation.

2.12 SOURCE QUALITY CONTROL

- A. Fabrication Tolerances:
1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within tolerance of plus or minus 1/16-inch measured diagonally across each sign.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine substrates and conditions under which signage will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:

- 1. Location:
 - a. Install signage and appurtenances at the locations shown or indicated. When locations are not shown or indicated, install signage at locations directed by ENGINEER.
 - b. Provide exit signs at locations shown or indicated. Surface-mount signs above each point of egress, unless otherwise shown or indicated.
 - c. Lightly mark and locate position of each sign. Obtain ENGINEER's acceptance of marked locations before mounting.
- 2. Installation – General:
 - a. Install signs level, plumb, and at proper height.
 - b. Signage shall be securely mounted with concealed, very-high-bond acrylic foam tape, specified adhesives, or mechanical fasteners where specified. Attach signs to surfaces in accordance with sign manufacturer's instructions, unless otherwise shown or indicated.
 - c. Provide very-high-bond acrylic foam tape on back of signage using a full perimeter of specified tape. Leave no gaps in tape perimeter at back of signage; peel off second release liner and press onto surfaces.
- 3. Repair or replace damaged units.

- B. Panel Signs – Room Identification, Directional, and Information Signs:

- 1. Where permanent identification is provided for rooms and spaces, install signs on the wall adjacent to the latch side of the door.
- 2. Where there is no wall space on the latch side of the door, including at double leaf doors, install signs on the nearest adjacent wall.
- 3. Mounting height shall be in accordance with ADA-ABA Accessibility Guidelines in areas accessible to disabled people. For other areas install signs with five feet from the finished floor to centerline of sign. Mount such signage so that a person may approach within three inches of the sign without encountering protruding objects or, when reading sign, be forced to stand within the swing of a door.

- C. Pipe Markers, Equipment Nameplates, and Pipe and Valve Tags:

- 1. Location of Pipe Markers and Pipe Tags:
 - a. Provide pipe markers with text (pipeline contents or service) and adjacent arrow indicating the direction of flow of pipeline contents on each piping system provided under the Project and other piping systems shown or indicated as to receive pipe markers.
 - b. Locations: Provide pipe markers at each of the following locations:

- 1) At intervals of not more than 30 linear feet apart
 - 2) Directly adjacent to each side of each penetration by the pipeline of the following: wall, floor, ceiling, roof.
 - 3) Adjacent to each change in flow direction.
 - 4) On each branch where pipes connect together including but not limited to tees, wyes, and crosses.
 - 5) Adjacent to each side of each valve (including but not limited to check valves, isolation valves, control valves, and other valves), strainer cleanouts, and each equipment item along the pipeline.
 - 6) Comply with ASME A13.1.
- c. Provide flow-direction arrows at intervals not greater than 15 linear feet. Where flow may be bi-directional, provide arrows adjacent to each other to indicate both directions.
 - d. Pipe marker locations will be determined by ENGINEER, but in general place pipe markers where personnel view of label is unobstructed. When pipeline is overhead, install label on the two lower quarters of the pipe or pipe covering. Pipe markers shall be clearly visible from personnel operating positions, especially operating positions adjacent to valves and equipment.
 - e. Provide pipe tags, where specified, at locations as specified for pipe markers.
2. Location of Valve Tags and Valve Nameplates:
 - a. Valve nameplates and valve signs for large valves shall be located on or adjacent to the valve.
 - b. For smaller valves, attach tags to valve bonnet or valve flange bolts.
 - c. For valves to receive equipment nameplates, as specified in this Section, install nameplate as required for other equipment nameplates.
 - d. Do not attach tags, nameplates, or signs to valve handwheels or other valve actuators.
 3. Equipment Nameplates:
 - a. Locate nameplates on equipment bases and on structures at readily-visible elevation in such positions relative to the equipment and structures as to prevent damage to nameplate.
 - b. Position nameplate for ease of reading by operations and maintenance personnel.
- D. Panel Signs – Right-To-Know Signs, Labels, and Tags:
1. Locate tags at intervals of not more than 20 feet center-to-center along chemical pipelines and fill pipelines and on each side of locations where pipelines emerge from penetrations with other materials.
 2. Install tank signs on each tank shown or indicated to receive signage at quarter-points on tank circumference, five feet above finished floor.
- E. Panel Signs – Site Entry, Directional, and Information Signs:

1. Install posts to concrete footings in accordance with sign manufacturer's written instructions. Refer to Sections 03 30 05, Concrete, and Section 31 20 00, Earth Moving.
2. Attach sign panels to posts in accordance with sign manufacturer's written instructions.

3.3 PROTECTION AND CLEANING

- A. After installation, clean soiled signage surfaces in accordance with manufacturer's written instructions.
- B. Protect signage from damage until completion of the Work.

+ + END OF SECTION + +

SECTION 10 28 05

TOILET AND BATH ACCESSORIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install toilet and bath accessories Work.
2. Extent of toilet and bath accessories is shown and specified.
3. Types of products required include the following:
 - a. Paper towel dispensers.
 - b. Toilet tissue dispensers.
 - c. Mirrors.
 - d. Grab bars.
 - e. Soap dispensers.
 - f. Towel and robe hooks.
 - g. Shower stall seats.
 - h. Shower curtain rods and hooks.
 - i. Soap dishes.
 - j. Miscellaneous fasteners, accessories and trim as required for a complete and functioning installation.

B. Coordination:

1. Furnish inserts and anchoring devices to be built into masonry for installation of toilet and bath accessories. Refer to masonry Specifications for installation of inserts and anchorage devices.
2. Coordinate toilet and bath accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of toilet and bath accessories
3. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before toilet and bath accessories Work.

C. Related Sections:

1. Section 04 00 05, Masonry.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/ICC A117.1, Accessible and Usable Buildings and Facilities.

2. NFPA 70, National Electric Code.

1.3 QUALITY ASSURANCE

- A. Component Supply and Compatibility:
 1. Provide products of the same manufacturer for each type of bath accessory unit and for units exposed in the same areas.
- B. Regulatory Requirements:
 1. Comply with the following:
 - a. Building code specified in Section 01 42 00, References.
 - b. Requirements of authorities having jurisdiction
 - c. ANSI/ICC A117.1
 - d. Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A, to 28 CFR Part 36 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Schedule of toilet and bath accessories indicating proposed location for each item.
 2. Product Data:
 - a. manufacturer's published literature, technical data, and specifications for each toilet and bath accessory item.
 3. Samples:
 - a. Standard and custom color charts for color selection by ENGINEER. Submit for each item under this Section where color or finish is not specified.
- B. Informational Submittals: Submit the following:
 1. Manufacturer's Instructions:
 - a. Setting drawings, templates, instructions, and directions for installing anchorage devices in other work.
 - b. Instructions for storing and installing materials furnished.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. General:
 1. Components and materials shall be suitable for their intended use and environment.
 2. Stamped names or labels on exposed faces of units are unacceptable.

3. Provide locks with the same keying for each type of toilet and bath accessory units in the Project, where possible. Furnish two keys for each lock.
4. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SURFACE-MOUNTED PAPER TOWEL DISPENSER

- A. Products and Manufacturers: Provide one of the following:
 1. No. 0210, by American Specialties, Inc.
 2. B-262, by Bobrick Washroom Equipment, Inc.
 3. Or equal.
- B. Requirements:
 1. Size to dispense not less than 400 c-fold towels with interchangeable paper drop.
 2. Construction: Cabinet and door not less than 22-gage stainless steel, No. 4 satin finish, all-welded construction, without mitered corners. Hang door with concealed, full-length stainless steel piano hinge
 3. Provide with tumbler-lockset.

2.3 TOILET TISSUE DISPENSERS

- A. General: Provide toilet tissue dispensers at each water closet.
- B. Products and Manufacturers: Provide one of the following:
 1. No. 0697-GAL, by American Specialties, Inc.
 2. B-2840, by Bobrick Washroom Equipment, Inc.
 3. Model 5263, by Bradley Corporation.
 4. Or equal.
- C. Multi-roll Toilet Tissue Dispenser and Ash Tray: Fabricate shelf of not less than 18-gage stainless steel, to store and dispense not less than two 4.5-inch by 4.5-inch core tissue rolls. Fabricate flange from a single piece, with seamless construction.

2.4 MIRRORS

- A. Accessible Tilt Mirrors:
 1. General: Provide accessible tilt mirror above each accessible lavatory.
 2. Products and Manufacturers: Provide one of the following:
 - a. No. 0535-B, by American Specialties, Inc.
 - b. B-293, by Bobrick Washroom Equipment, Inc.
 - c. Model 740-1836, by Bradley Corporation.
 - d. Or equal.

3. Stainless Steel Frame: Fabricate frame from 20-gage, Type 304L stainless steel, welded and ground smooth, no shelf. Mirrors shall be 1.5 feet by three feet size, with tilting frame tapered from 1.5 inches at bottom to 4.5 inches at top.

2.5 GRAB BARS

- A. General: Provide grab bars where shown. Provide custom specials where required or specified.
- B. Products and Manufacturers: Provide one of the following:
 1. 3200 P Series custom Type 56 with 54-inch leg and 36-inch leg, by American Specialties, Inc.
 2. B-68137.99, by Bobrick Washroom Equipment, Inc.
 3. Model 812-2, Type 059 by Bradley Corporation.
 4. Or equal.
- C. Custom Stainless Steel Grab Bars:
 1. Provide stainless steel knurled grab bars, 1.5-inch outside diameter, 16-gage.
 2. Mounting: Concealed, with manufacturer's standard flanges and anchorages for type of installation.
 3. Provide custom dimensions specified.

2.6 SURFACE-MOUNTED HORIZONTAL LIQUID SOAP DISPENSER/SHELVES

- A. General: Provide surface-mounted liquid soap dispensers, one per lavatory.
- B. Products and Manufacturers: Provide one of the following:
 1. No. 0318, by American Specialties, Inc.
 2. B-2014, by Bobrick Washroom Equipment, Inc.
 3. Model 66, 1 by Bradley Corporation.
 4. Or equal.
- C. Liquid Soap Dispenser:
 1. Units shall be 20 inches long by 2.5 inches high by 4-5/10 inches wide, with one liquid soap dispensing valve
 2. Capacity: 80 fluid ounces.
 3. Fabricate units of 20-gage stainless steel, with pin-type tumbler locking device. Provide 20-gage stainless steel shelf using one-piece construction, with integral sides. Dispense liquid soap in measured quantity by pump action with stainless steel internal springs, ABS piston, stainless steel push button and internal parts. Cabinet shall have no exposed fastening devices.
 4. Locking: Pin-type tumbler lock.

2.7 MISCELLANEOUS ITEMS

- A. Combination Shelf with Utility Hook and Mop Strip:

1. Products and Manufacturers: Provide one of the following:
 - a. No. 1304-A, by American Specialties, Inc.
 - b. B-239x34, by Bobrick Washroom Equipment, Inc.
 - c. Model 9934, by Bradley Corporation.
 - d. Or equal.
 2. Provide 18-gage stainless steel shelf with 3/4-inch lip, five 18-gage stainless steel hook strips, and four mop holders. Shelf shall be 34 inches wide and eight inches deep.
- B. Towel and Robe Hooks:
1. For each indicated, provide two double concealed-mounting hooks. Cast brass with polished chrome finish.
 2. Products and Manufacturers: Provide one of the following:
 - a. 0751, by American Specialties, Inc.
 - b. B-2116, by Bobrick Washroom Equipment, Inc.
 - c. Model 9119 by Bradley Corporation.
 - d. Or equal.
- C. Shower Stall Seats:
1. Provide folding handicapped shower stall seat constructed of one-inch diameter stainless steel tubing with 1/2-inch thick solid, white phenolic seat.
 2. Products and Manufacturers: Provide one of the following:
 - a. 8206-L or R Folded Seat, by American Specialties, Inc.
 - b. B-5181, by Bobrick Washroom Equipment, Inc.
 - c. Model 9569-000000, by Bradley Corporation.
 - d. Or equal.
- D. Shower Curtain Rods and Hooks:
1. Provide for each shower one shower curtain rod and required number of hooks.
 2. Products and Manufacturers: Provide one the following:
 - a. No. 1204 Extra Heavy-Duty Shower Curtain Rods with No. 1200-SHU Shower Curtain Hooks, by American Specialties, Inc.
 - b. B-6047 with 204-1 Hooks, by Bobrick Washroom Equipment, Inc.
 - c. Model 9531 with 9540 Curtain Hooks, by Bradley Corporation.
 - d. Or equal.
 3. Provide stainless steel, 1.25-inch diameter extra-heavy-duty, 18-gage shower curtain rods with satin finish and with three-inch diameter, stainless steel rod flanges; two per rod.
 4. Provide chrome finished shower curtain snap hooks; one for each shower curtain grommet.
- E. Shower Curtains:
1. Provide shower curtain for each shower.
 2. Products and Manufacturers: Provide one of the following:
 - a. No. 1200-V Vinyl Shower Curtains, by American Specialties, Inc.
 - b. No. 204-2, by Bobrick Washroom Equipment, Inc.

- c. Model 9537, by Bradley Corporation.
 - d. Or equal.
 - 3. Flame-resistant, anti-bacterial, eight-gage vinyl fabric with rustproof nylon reinforced chrome-plated grommets.
 - 4. Height: Seven feet.
 - 5. Width: Provide curtain six inches wider than shower stall openings.
 - 6. Color: Full selection of manufacturer's standard and custom colors.
- F. Surface-Mounted Soap Dishes:
- 1. Products and Manufacturers: Provide one of the following:
 - a. No. 7320, by American Specialties, Inc.
 - b. B-7680, by Bobrick Washroom Equipment, Inc.
 - c. Model 9014-63, by Bradley Corporation.
 - d. Or equal.
 - 2. Material: Drawn, one-piece stainless steel.
- G. Undersink Guards:
- 1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
 - 2. Product and Manufacturer: Provide one of the following:
 - a. HANDY SHIELD-MAXX, by Plumberex Specialty Products, Inc.
 - b. Truebro Lav Guard 2, by IPS Corporation.
 - c. Or Equal.
 - 3. Material and Finish: Anti-microbial, molded plastic, white.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine the areas and conditions under which toilet and bath accessories will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install items required to meet accessibility codes in accordance with Laws and Regulations, and ANSI/ICC A117.1.
- B. Determine that substrates are completed and ready to accept surface-mounted or recessed accessories. Refer to Section 04 05 05, Unit Masonry Construction, for substrate requirements.
- C. Use concealed fastenings where possible.

- D. Provide anchorage devices, fasteners, and other necessary anchorages, and attach accessories securely to walls, floors, and partitions in locations as shown and as required.
- E. Install concealed mounting devices and fasteners fabricated of the same material as the accessories as recommended by manufacturer.
- F. Install exposed mounting devices and fasteners finished to match the accessories.
- G. Provide theft-resistant fasteners for all mountings.
- H. Secure and install toilet and bath accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.
- I. Lock grab bars to concealed mounting plate installed in wall.

3.3 ADJUSTMENT AND CLEANING

- A. Adjust toilet and bath accessories for proper operation.
- B. After completion of installation, clean and polish all exposed surfaces.
- C. Deliver keys and instruction sheets to OWNER in accordance with Section 08 71 00, Door Hardware.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 10 44 00

FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all fire protection specialties Work.
 - 2. Extent of fire protection specialties Work is shown and specified.
 - 3. Types of fire protection specialties Work required includes:
 - a. Dry chemical extinguishers.
 - b. Carbon dioxide extinguishers.
 - c. Mounting accessories and miscellaneous fasteners.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before fire protection specialties.
- C. Related Sections:
 - 1. Section 10 14 00, Signage.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL Fire Classification Rating.

1.3 QUALITY ASSURANCE

- A. Component Supply and Compatibility:
 - 1. Provide fire protection specialties products from one manufacturer.
- B. Regulatory Requirements: Provide fire protection specialties approved and labeled by UL.

1.4 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: Submit the following:
 - a. Manufacturer's technical data, certification of UL rating, and installation instructions for fire protection specialties.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. General: Provide manufacturer's standard mounting brackets for portable fire extinguishers size as specified.
- B. Multi-Purpose Dry Chemical Fire Extinguishers:
 - 1. Ten-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires, UL rating 4A-60 BC.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Cosmic Model 10E by J.L. Industries.
 - b. Or equal.
- C. Carbon Dioxide Fire Extinguishers:
 - 1. Ten-pound enameled steel container capacity, for Class B and Class C fires UL rating.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Sentinel Model 10 by J.L. Industries.
 - b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine substrates and conditions under which fire protection specialties will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to ENGINEER.

3.2 INSTALLATION OF FIRE EXTINGUISHERS

- A. When exact locations of fire protection specialties are not shown on Drawings, locate as directed by ENGINEER.
- B. Securely fasten products to structure, square and plumb, per Supplier's instructions. Mounting heights shall be:
 - 1. Install fire extinguishers with gross weight greater than 40 pounds with top of fire extinguisher no more than 3.5 feet above finished floor.
 - 2. Install fire extinguishers with gross weight less than 40 pounds with top of fire extinguisher no more than 4.0 feet above finished floor.
 - 3. Clearance between bottom of fire extinguisher and finished floor shall be at least four inches.
- C. Identification Devices: Provide signs level and plumb directly above surface mounted portable fire extinguishers, securely mounted, attached to substrate per sign

manufacturer's instructions. Signage shall be per Section 10 14 00, Signage.

- D. Recharge fire extinguishers provided under this Contract so that most recent inspection date coincides as nearly as possible with date of Substantial Completion. Inform OWNER in writing of next required inspection and recharging date.

3.3 FIRE EXTINGUISHER SCHEDULE

- A. Type A – Dry chemical, wall mounted.
 - 1. All locations except as noted below.
- B. Type B – Carbon dioxide, wall mounted.
 - 1. Electrical Room.

+ + END OF SECTION + +

++NO TEXT ON THIS PAGE++

SECTION 10 51 00

LOCKERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all locker Work.
 - 2. Extent of lockers is shown.
 - 3. Types of products required include the following:
 - a. All welded, factory-assembled, heavy-duty single-tier metal lockers.
 - b. Laminated maple benches.
 - c. Miscellaneous accessories, closures, identification labels and other components, trim and fasteners.
- B. Coordination:
 - 1. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 05, Concrete.
- C. Related Sections:
 - 1. Section 03 30 05, Concrete.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 666-1, Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
 - b. ASTM A 1008/A 1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - 2. U.S. Architectural and Transportation Barriers Compliance Board. Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG). Continual Revisions.

1.3 QUALITY ASSURANCE

- A. Provide metal lockers as complete units produced by a single manufacturer, including necessary mounting accessories, fittings, and fastenings.
- B. Color:
 - 1. Provide locker units in color selected by ENGINEER from manufacturer's standard and custom colors. Minimum order requirements of the manufacturer

- shall not be acceptable cause by CONTRACTOR for rejection of ENGINEER'S color selection.
2. Unless otherwise shown, non-exposed surfaces may be manufacturer's standard neutral color as selected by ENGINEER.
 3. Manufacturer's of "or equal" products shall be able to supply exactly the same construction and color selections as the manufacturer's specified.
- C. Regulatory Requirements: Where metal lockers are indicated to comply with accessibility requirements, comply with Accessibility Guidelines for Buildings and Facilities (ADAAG) and the International Building code.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Shop Drawings for metal lockers, verifying dimensions affecting locker installations. Show lockers in detail, method of installation, fillers, trim, base and accessories. Include locker numbering sequence information.
 2. Product Data:
 - a. Copies of manufacturer's technical data, color charts, and installation instructions for the metal locker units.
 3. Samples: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
 - a. For the following products, in manufacturer's standard sizes, showing the full range of color, texture, and pattern variations expected. Prepare Samples from the same material to be used for the Work.
 - 1) Lockers.
 - 2) Locker benches.
- B. Closeout Submittals: Submit the following:
1. Warranty Documentation: Manufacturer's Warranty.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver metal lockers until building is enclosed and ready for their installation. Protect from damage during delivery, handling, storage, and installation.
- B. Deliver master keys, control keys, and combination control charts to OWNER.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify the following by field measurements before fabrication and indicate measurement on Shop Drawings:
1. Concealed framing, blocking and reinforcements that support metal lockers before they are enclosed.
 2. Recessed openings.
 3. Concrete bases.

1.7 WARRANTY

- A. Provide manufacturer's ten-year warranty against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653/A 653M, commercial quality, G60 (Z180) coating designation; mill phosphatized; suitable for exposed applications, and stretcher leveled or roller leveled to stretcher-leveled flatness.
- B. Maple: Laminated.
- C. Fasteners: Zinc- or nickel-plated steel, slotless-type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.

2.2 HEAVY DUTY LOCKER CONSTRUCTION

- A. Frames: Minimum 16 gage channels or 12 gage angles, with corners electrically welded to form a rigid one-piece structure. Form door stop at vertical members.
- B. Backs and Sides: Minimum 18 gage steel for backs; 16 gage steel for sides. Flange backs on vertical edges, and sides where they intermember with backs, making double-flanged rear corners.
 - 1. Exposed ends of non-recessed lockers; minimum 16 gage steel.
- C. Tops, Bottoms and Shelves: Minimum 16 gage steel, flanged edges.
- D. Double Panel Doors: One-piece, formed solid doors with louvers top and bottom minimum 14 gage cold-rolled sheet steel with double bends on both sides and single bends on top and bottom and an 18 gage formed inner panel welded to outer door to form a reinforcing channel. Construct doors to prevent springing when opening or closing. Fabricate doors to swing 180 degrees.
 - 1. Provide stamped louvered vents in door faces, as follows:
 - a. For single-tier lockers, not less than six louver openings top and bottom.
- E. Door Hinges: Heavy-duty, not less than 16 gage steel, full-loop, continuous full length piano hinges. Weld hinges to inside of frame and secure to door with not less than two factory-installed fasteners, completely concealed and tamperproof when locker door is closed.
- F. Center Partition: Provide center partition in each 24-inch wide locker.

- G. Latching: Positive, automatic, pre-locking, pry-resistant latch and fully recessed latch with rubber bumpers riveted to door stops and heavy-duty, rigid non-moving 11 gage hasp containing strike and hole for padlock.
 - 1. Provide stainless steel pan recessed into door containing no moving parts for through-the-door padlock.
 - 2. Provide single point latch welded to door frame.
- H. Sizes:
 - 1. Clothes Lockers: 15-inches wide by 15-inches deep by 72-inches high with closed base and legs.
- I. Products and Manufacturers: Provide one of the following:
 - 1. All-Welded Lockers by Penco Products, Incorporated.
 - 2. All-Welded Integrated Frame Lockers by Lyon Workplace Products.
 - 3. Or equal.

2.3 FINISH

- A. Chemically pretreat metal with degreasing and phosphatizing process. Electrostatically spray and bake enamel finish to all surfaces, exposed and concealed, except plates and non-ferrous metal. Provide manufacturer's full selection of standard and custom colors.

2.4 LOCKER ACCESSORIES

- A. Locking: Fabricate lockers to receive padlocks which shall be provided by OWNER.
- B. Equipment: Furnish each locker with the following accessories:
 - 1. Single-Tier Units: Clothing rod, 7/8-inch diameter heavy chrome plated steel, three single-prong wall hooks, and shelf.
- C. Number Plates: Manufacturer's standard etched, embossed, or stamped, non-ferrous metal number plates with numerals not less than 3/8-inch high. Number the lockers in sequence as directed by ENGINEER. Attach plates to each locker door, near top, centered, with at least two stainless steel fasteners of the same finish as number plate.
- D. Continuously Sloping Tops: Manufacturer's standard, fabricated from minimum 20-gage steel sheet, for installation over lockers with separate flat tops. Fabricate tops in lengths as long as practicable, without visible fasteners at splice locations, finished to match lockers. Provide vertical end closures.
- E. Trim: Provide fill-in-panels, solid end panels and recessed trim consisting of 16 gage minimum cold-rolled steel, as necessary, to provide complete and finished installation. Factory-finish trim to match lockers. Secure trim to lockers with concealed fastening clips. Provide recessing trim on all top and sides as required for a complete and finished installation.

2.5 LOCKER ROOM BENCHES

- A. Manufacturer's standard units with laminated hardwood tops approximately 9-1/2-inch wide by 1-1/4-inch thick, in lengths as shown. Furnish 1-1/2-inch diameter tubular steel pedestal supports not more than 6 feet-0 inch on centers, with provisions for concealed fastening to floor and securing to bench. Furnish all anchorages. Finish bench tops with manufacturer's standard clear coatings and pedestals with baked enamel paint custom finished to match locker color.

2.6 FABRICATION

- A. Construction: Provide all seams and joints including sides, back, top and bottom and hinges and shelves of welded construction. Bolts, screws or pop rivets are not approved. Fabricate lockers square, rigid, and without warp, with metal faces flat and free of dents or distortion. Make all exposed metal edges and welds safe to the touch.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR and his installer must examine the areas and conditions under which locker Work is to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

- A. Install lockers required to meet accessibility codes in accordance with ANSI 117.1 and the International Building Code .
- B. Install metal lockers at the locations shown in accordance with the manufacturer's instructions for a plumb, level, rigid, and flush installation.
- C. Space fastenings about 48-inch on centers and apply through back-up reinforcing plates where necessary to prevent metal distortion. Conceal all fasteners.
- D. Install trim, to provide a flush, hairline joint against adjacent surfaces. Install with concealed fasteners.
- E. Touch-up marred finishes, or replace if not acceptable to ENGINEER. Use only materials and finishes as recommended or furnished by the locker manufacturer.
- F. Adjust doors and latches to operate easily without bind. Verify satisfactory operation of integral locking devices.

G. Install benches in accordance with manufacturer's instructions and recommendations.

++ END OF SECTION ++

SECTION 11 32 00

UNIT KITCHENS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all unit kitchen Work.
2. Extent of unit kitchens is shown.
3. Types of products required include the following:
 - a. Metal base and wall cabinets.
 - b. Countertops and backsplashes.
 - c. Sinks.
 - d. Appliances
 - 1) Refrigerator
 - 2) Microwave
 - e. Accessories.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate them with the Work of this Section.
2. Furnish inserts and anchoring devices which must be set in concrete or built into masonry and recycled gypsum wallboard for the installation of unit kitchens. Coordinate delivery with other work to avoid delay.
3. Refer to masonry Sections of these Specifications for installation of inserts and anchorage devices. Refer to Section 04 00 05, Masonry.

C. Related Sections:

1. Section 04 00 05, Masonry.
2. Section 06 10 53, Miscellaneous Rough Carpentry.
3. Division 22, Plumbing.
4. Section 26 05 33.13, Rigid Conduits.
5. Section 26 05 33.16, Flexible Conduits.
6. Section 26 05 33.36, Outlet Boxes.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI A208.2-2002: Medium Density Fiberboard for Interior Use.
2. ANSI Z21 Series for Gas Appliances.
3. ASTM A 240/A 240M-06b: Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

4. ASTM A 1008/A 1008M-05b: Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
5. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
6. EPA/DOE ENERGY STAR Product Labeling Program.
7. ICC/ANSI A117.1-2003: Accessible and Usable Buildings and Facilities.
8. ISSFA-2-2001: Classification and Standards Publication of Solid Surfacing Material
9. KCMA A161.1-2000: Performance & Construction Standard for Kitchen and Vanity Cabinets (ANSI).
10. NAAMM, Metal Finishes Manual for Architectural and Metal Products. 1988.
11. NEMA LD 3: High Pressure Decorative Laminates (ANSI).
12. NFPA 70: National Electrical Code.
13. Underwriters Laboratories, Inc. (UL) – Safety standards for electric appliances
14. UL 250: Household Refrigerators and Freezers.
15. UL 858: Household Electric Ranges.
16. UL 923: Microwave Cooking Appliances.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: A qualified manufacturer, that produces unit kitchens of types indicated for this Project.
- B. Installer's Qualifications:
 1. Engage a single installer regularly performing installation of unit kitchens with documented skill and successful experience in the installation of the types of unit kitchens required; and who agrees to employ workers for this Project who are trained or certified by manufacturer for installation techniques required for the types of materials specified.
 2. Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
 - a. Names and telephone numbers of owners, architects or engineers responsible for projects.
 - b. Approximate contract cost of the unit kitchen Work.
 - c. Lineal footage of unit kitchens installed.
- C. Testing Agency Qualifications: The independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work in accordance with ASTM E 329, without delaying the Work.
- D. Component Supply and Compatibility:
 1. Provide unit kitchen products manufactured or furnished by the same unit kitchens manufacturer for single responsibility.

2. No reduction of special production capabilities is acceptable for the Work of this Section.
 3. Manufacturers of “or equal” products shall be able to provide same complete selection of standard, custom-color and multi-color unit kitchens provided by the manufacturers specified, as well as full custom manufacturing capabilities and all accessories.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, UL listed, and marked for intended location and application.
1. Built-in Refrigerators: Listed and labeled for recessed installation. Mount label to be visible after installation of unit; include electrical rating, type of refrigerant and minimum installation clearances.
 2. Refrigerated Unit Kitchens: Listed and labeled for entire unit as a single integrated system. Mount label to be visible after installation of unit; include electrical rating, type of refrigerant and minimum installation clearances.
- F. Appliance Standards:
1. Refrigerators and Freezers: UL 250.
 2. Microwave Ovens: UL 923.
- G. ENERGY STAR Rating: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - a. Wiring Diagrams: For power, signal, and control wiring.
 2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, finishes, furnished specialties, and accessories. Include rated capacities, operating characteristics, and utility requirements of appliances.
 3. Samples:
 - a. Metal finish for cabinets, 8 by 10 inches.
 - b. One full-size unit of each type of exposed hardware.
- B. Informational Submittals: Submit the following:
1. Certification:
- C. Products specified.
1. Test and Evaluation Reports:
 - a. Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of unit kitchens with requirements of specified product standard and system structural performance specified in Article 2.1.

- b. Product test reports for countertop surface material: based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of countertop surface materials with requirements specified for chemical and physical resistance.
 - 2. Manufacturer's Instructions:
 - a. Installation Data.
 - b. Procedures and precautions for protecting unit kitchen Work.
 - 3. Qualification Statements:
 - a. Manufacturer.
 - b. Installer.
 - c. Testing Agency.
- D. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data: Provide detailed maintenance manual for products specified in this Section. Conform to Section 01 78 23, Operation and Maintenance Data, and include:
 - a. Identify Manufacturer, product name, and model number of each product used in the Work.
 - b. Name, address and telephone number of Manufacturer, local distributor, and technical representative.
 - c. Detailed procedures for routine maintenance and cleaning.
 - d. Detailed procedures for light repairs such as dents, scratches, and staining.
 - 2. Warranty Documentation:
 - a. Finishes.
 - b. Appliances.
- E. Maintenance Material Submittals: Submit the following:
 - 1. Spare Parts
 - a. Furnish complete touchup kit for each type and color of unit kitchens provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged unit kitchens finish.
 - b. Furnish complete touchup kit for each type and color of unit kitchens counter tops provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged counter top finish.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-assembled units, individually factory packaged and protected. Label with manufacturer's name, product name, and model number. Conform to Sections 01 65 00, Product Delivery Requirements and 01 66 00, Product Storage and Handling Requirements.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install unit kitchens until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of construction contiguous with unit kitchens by field measurements before fabrication.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that unit kitchens can be supported and installed as indicated.
- B. Coordinate wiring requirements and current characteristics of unit kitchens with building electrical system. Refer to Section 26 05 33.13, Rigid Conduits and Section 26 05 33.36, Outlet Boxes.
- C. Coordinate layout and installation of plumbing, mechanical, and electrical services for unit kitchens.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace unit kitchens components listed below.
 - 1. Refrigerator system and other appliances: 5-years.
 - 2. Steel Cabinetry: 10 years.
 - 3. Stainless Steel Countertops: 10 years.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

2.2 METAL CABINETS

- A. Stainless Steel Base Cabinets: Fabricate frames and sides from 20-gage thickness, Stainless steel sheet; welded and reinforced with internal gussets and bracing; with No 4 finish.

1. Door and Drawer Fronts: 20-gage thickness, stainless steel sheet, smooth; welded, reinforced, and sound-deadened; with No 4 finish.
- B. Under counter Storage Cabinet: Same material and finish as base cabinets, with adjustable shelf and drawer or with two drawers.
- C. Wall Cabinets: Same material and finish as base cabinets, with flush double bottoms and adjustable shelves.
 1. Wall Shields: Fabricated from same material and finish as base cabinets. Provide wall shields for back wall and side walls between countertop splash and wall cabinets.
- D. Shelves: Manufacturer's standard rolled-front shelves, adjustable, of same material and finish as cabinets.
- E. Wire Pulls: Stainless-steel.

2.3 COUNTERTOPS

- A. Countertop and Integral Sink: Seamless, one-piece countertop and sink with integral embossed drain board and backsplash and side splashes.
 1. Stainless Steel: 16 gage sheet; Type 304.
 - a. Countertop for Drop-in Sink: Seamless, one-piece countertop with integral backsplash and side splashes.

2.4 FIXTURES

- A. Supplies: NPS 1/2 chrome-plated copper with stops.
- B. Sink Faucet: Single-lever control; chrome finish.
- C. Sink Outlet: 3-1/2-inch-diameter outlet with stainless-steel cup strainer and 1-1/2-inch-diameter tailpiece.
- D. Drain Piping: NPS 1-1/2 chrome-plated cast-brass trap, tubular brass waste to wall, and wall escutcheon.

2.5 APPLIANCES

- A. ENERGY STAR Rating: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
- B. 30" Freestanding, Undercounter Refrigerator: One-door unit with one-piece seamless steel or ABS plastic inner liner; automatic defrost; interior light; adjustable automatic temperature control; door with magnetic gaskets and storage shelves; 115- VAC, with three-conductor, grounded power cord.
 1. Minimum Capacity: Minimum 5.6-cu. ft. refrigerator capacity.
 2. Color: Manufacturer's Stainless Steel Finish.

- C. Countertop Microwave Oven: Countertop, minimum 1.5-cu. Ft. capacity with 950-W cooking power; electronic touch controls, variable power control, digital clock timer, interior light, turntable, tempered glass door; 115-VAC, with three-conductor, grounded power cord.
 - 1. Color: Stainless Steel Finish.

2.6 ACCESSORIES

- A. Locks: Brass-cylinder type; furnish two keys per lock. Provide at all cabinets.
- B. Fluorescent Light Fixtures: Surface mounted to underside of overhead cabinet; with 15-W lamp, on-off switch, grounded convenience receptacle, and translucent plastic lens.

2.7 FABRICATION

- A. General: Factory fabricates and assembles unit kitchens, with base cabinets, sink, refrigerator, and countertop shipping as a one-piece assembly. Securely fasten components, fixtures, and appliances together.
 - 1. Provide manufacturer's standard hardware including concealed, adjustable plated-steel hinges; steel drawer slides with nylon rollers; and catches and rubber bumpers on doors and drawers. Unless otherwise indicated, provide chromium-plated metal or satin-finished stainless steel for exposed hardware.
- B. Units: Fabricate unit kitchens to comply with accessibility regulations as follows:
 - 1. Standard, Countertops: Fabricate unit kitchens with one-piece countertop located at height of 34 inches above floor.
 - 2. Knee and Toe Clearance: Provide minimum 30-inch- wide open space beneath countertop with a minimum clear height of 27 inches above floor for first 8 inches of depth, then reduce clearance at a rate of 1 inch in depth for each 6 inches in height, to a minimum clear height of 9 inches above floor at a depth of 11 inches.
 - 3. Pipe Enclosure Panels: Provide manufacturer's standard panels to enclose plumbing under countertop, of same material and finish as cabinets. Install panel to prevent exposure of sharp or abrasive surfaces under countertop.
 - 4. Operable Parts: Locate operable parts no higher than 48 inches and no lower than 15 inches above floor. Provide operable parts that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbs.

2.8 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Stainless-Steel Finishes: Remove tool and die marks and stretch lines, or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 1. Bright, Directional Polish: No. 4 finish.

2.9 UNIT KITCHENS

- A. Unit Kitchen:
 - 1. Cabinets: Factory-finished steel.
 - a. Wall Cabinets: Required.
 - 1) Wall Shields: Same as the cabinets.
 - b. Color: As selected from manufacturer's standard range.
 - 2. Countertop: Stainless steel.
 - a. Integral Sink: Stainless steel, single bowl with basket strainer and tail piece.
 - 3. Fixtures:
 - a. Sink Faucet: single-lever control, swing spout.
 - 4. Appliances:
 - a. Refrigerator: Built in, 5.6 cf.
 - b. Microwave Oven: Recirculating, non-ventilating hood.
 - 5. Accessories: Fluorescent light fixture.
 - 6. Orientation: No end walls.
 - 7. Width: 84-inches.
 - 8. Product and Manufacturer: Provide one of the following:
 - a. Custom and Modified Classic Series Kitchen MR by Dwyer Products.
 - b. Custom Model ROE 9Y99RH+WCMO Efficiency Kitchenettes by Acme Kitchenettes Corporation.
 - c. Custom Model KSE 120-inch wide Unit by Kitchen Systems, Inc.
 - d. Or Equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Contractor and installer shall examine the areas and conditions under which unit kitchens and related items are to be installed. Notify Engineer, in writing, of conditions detrimental to the proper and timely completion on the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner to Engineer.

3.2 PREPARATION

- A. Examine walls and partitions for proper backing for unit kitchens. Refer to Section 04 00 05, Masonry and Section 06 10 53, Miscellaneous Rough Carpentry, for substrate construction.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims. Provide fasteners, clips, backing materials, brackets, anchors, fillers, scribes, trim, and accessories necessary for complete installation.
 - 1. Anchor unit kitchens at ends and at intervals recommended by manufacturer, but not more than 36 inches on centers. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent material distortion; use concealed fasteners.
 - 2. Freestanding Ranges: Install anti-tip anchors at locations recommended by manufacturer.
- B. Comply with requirements specified in Division 22, Plumbing; and Division 23 , HVAC for connecting unit kitchens to plumbing systems.
- C. Comply with requirements specified in Section 26 05 33.13, Rigid Conduits; Section 26 05 33.16, Flexible Conduits; and Section 26 05 33.36, Outlet Boxes for connecting unit kitchens to electrical power system.

3.4 ADJUSTING AND CLEANING

- A. Test, adjust, and verify operation of each appliance, plumbing fixture, and component of unit kitchens. Repair or replace items found to be defective or operating below rated capacity.
- B. Verify that operating parts work freely and fit neatly and that clearances are adequate to properly and freely operate appliances.
- C. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that locking devices operate properly.
- D. After completing unit kitchen installation, remove protective coverings if any.
- E. Repair or replace damaged parts, dents, buckles, abrasions, and other defects affecting appearance or serviceability. Touch up factory-applied finishes to restore damaged or soiled areas.

3.5 FIELD QUALITY CONTROL

- A. Field Quality Control:

1. After installation and completion of connections, with Engineer, verify installation and proper functionality of all Work included in this Section. Correct deficiencies until all Work functions properly.

++END OF SECTION++

SECTION 12 21 00

WINDOW BLINDS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all window blind Work.
2. Extent of window blind units is specified.
3. Types of products required include the following:
 - a. Manually-operated horizontal window blinds.
 - 1) Provide at all windows in Garage 102, Restroom 105 and Control Room 106.
 - b. Miscellaneous accessories and materials.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate with the Work of this Section.
3. Provide inserts and anchoring devices to be built into masonry for installation of window blinds. Coordinate delivery with other work to avoid delay.
4. Refer to concrete and masonry Sections of the Specifications for installation of inserts and anchorage devices. Refer to Section 04 00 05, Masonry.

C. Related Sections:

1. Section 04 00 05, Masonry.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. GANA, Glazing Manual.
2. NFPA 701, Methods of Fire Tests for Flame Propagation of Textiles and Films.
3. WCMA A100.1, American National Standard for Safety of Corded Window Covering Products.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:

1. Provide all window blinds of each type of blinds required as complete units produced by one manufacturer, including hardware, accessory items, mounting brackets, and fastenings.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Shop Drawings for special window blind components THAT are not fully dimensioned or detailed on manufacturer's product data. Include elevation layout indicating proposed division between window blind units and meeting edges at corners.
 - b. Coordinated drawings showing required clearances to window obstructions and other obstructions that would interfere with window blind operation. Coordinate pocket size and mounting with manufacturer's proposed products and show details and all dimensions on Shop Drawings.
 - c. Data sheets for window blinds proposed for use.
 - 2. Product Data:
 - a. Manufacturer's published literature, catalog sheets, and specifications for each type of window blind proposed for use.
 - 3. Samples:
 - a. Submit six-inch Samples of window blinds in all standard colors for selection by ENGINEER.
 - b. ENGINEER's review of Samples will be for color and texture only. Compliance with other requirements of the Contract Documents is CONTRACTOR's responsibility.
- B. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data: Submit window blinds operations and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Deliver window blinds in factory packaging, marked with manufacturer, product name, and installation location using same designations indicated on the Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not install window blinds until construction and wet and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for the Project when occupied for its intended use.
- B. Field Measurements: Where window blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Advise ENGINEER in

writing of installation conditions that vary from those required in the Contract Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Horizontal Window Blinds:

1. Products and Manufacturers: Provide one of the following:
 - a. Riviera 1/2-inch Mini-Blinds, by Levolor Window Fashions, a Newell Rubbermaid Company.
 - b. Décor 1/2-inch Solids Mini-Blinds, by Hunter Douglas Contract, Hunter Douglas, Inc.
 - c. Or equal.
2. Head Channel: 0.025-inch thick tomized steel, U-shaped one-inch high by 1-9/16-inch wide with flanged edges at top, and coated with a baked-on finish. All hardware shall be enclosed in the metal head.
3. Tilter: 0.042-inch tomized steel with automatically disengaging worm and gear mechanism to eliminate overdrive and prevent strain or damage to window blinds.
4. Tilt Wand: Transparent with hexagonal cross section of 5/16-inch across flats.
5. Drum and Cradle: One for each window blind ladder as follows:
 - a. Drum shall be 0.031-inch tomized steel having two holes with rolled edges to anchor barbs on both ladder ends.
 - b. Cradles shall be 0.042-inch thick tomized steel, having two holes with rolled edges to guide cords through bottom of head channel without abrasion.
6. Tilt Rod: U-shaped with a circular radius of approximately 1/8-inch designed to achieve minimum torsional deflection. For window blinds greater than five feet wide and less than 6.67 feet long, or greater than 4.583 feet wide and greater than 6.67 feet long tilt rod shall be a solid D-shaped rod with an average cross section of 1/4-inch designed to achieve minimum torsional deflection.
7. End Braces: 0.037-inch thick tomized steel with reinforcing ribs and field adjustable tabs.
8. Installation Brackets: Provide brackets with a rivet-hinged safety locking front cover not less than 0.048-inch thick tomized steel with baked-on finish matching head channel.
9. Intermediate Brackets: 0.050-inch tomized steel installed with window blinds greater than five feet wide and less than 6.67 feet long, or greater than 4.583 feet wide and greater than 6.67 feet long.
10. Ladders (slat supports): Braided polyester yarn designed from maximum strength and flexibility combined with minimum stretch. Rungs shall consist of not less than two crossed cables interbraided with the vertical components. Ladders shall support the slats without visible distortion. Distance between ladders shall not exceed two feet for window blinds up to 6.67 feet long. For

window blinds over 6.67 feet long, distance between ladders shall be not greater than 22 inches.

11. Slats: Virgin high magnesium aluminum, alloyed for maximum strength and corrosion resistance. Slats shall be nominally eight-gage, 1/2-inch wide with an elliptical crown formed after coating and curing. Slat ladder support distances shall prevent visible sag or bow after continued use indoors. Slats shall be unperforated.
12. Bottom Rail: 0.031-inch tomized steel formed after coating provided with color-compatible molded plastic ladder and end caps.
13. Lift Cord: Braided of high-strength flexible polyester fiber cord with minimum stretch and maximum abrasion resistance characteristics. Cord shall be of sufficient length, equalized to properly control raising and lowering of window blinds and spaced not more than 3.83 feet between cords.
14. Colors: Complete selection of manufacturer's standard colors. ENGINEER will select a maximum of three colors for the Work.
15. Accessories: Provide the following:
 - a. Pocket installation brackets.
 - b. Projection brackets to clear window hardware.
 - c. Two-tone slats with neutral white on outside face.

2.2 FABRICATION AND OPERATION

- A. Product Safety Standard: Fabricate vertical louver blinds to comply with WCMA A100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.
- B. Prior to fabrication, verify actual opening dimensions by accurate Site measurements. Adjust dimensions for proper fit at all openings.
- C. Fabricate components of window blinds from non-corrosive, non-staining, non-fading materials which are compatible with each other, and which do not require lubrication during normal expected life. Use dissimilar metals or plastics for contact surfaces which slide against each other in operation of window blinds.
- D. Fabricate window blind units to completely fill the openings as shown, from head-to-sill and jamb-to-jamb. For continuous window wall installations, fabricate window blinds so that ends occur only at mullions or other defined vertical separations, unless otherwise shown.
- E. Gear all operating equipment for reduction of the ratio of hand-movement to window blind-movement, so that window blinds operate easily and can be set accurately and smoothly.
- F. Concealed Components:
 1. Noncorrodible or corrosion-resistant-coated materials.

2. Rotation-and-Traverse Mechanisms: With permanently lubricated moving parts.
- G. Installation Brackets: Constructed for easy removal and reinstallation of blind, for supporting headrail and operating hardware and for bracket positions and blind mounting method indicated.
- H. Installation Fasteners: Not less than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
- I. Color-Coated Finish: For metal components exposed to view unless anodized or plated finish is indicated. Apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine the substrates and conditions under which the window blinds Work will be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
 1. Install window blinds where shown and in accordance with manufacturer's instructions. Position units plumb and true, securely anchored in place with proper clips, brackets, and bolts for the type of mounting required.
 2. Locate so exterior vane edges are not closer than two inches from interior faces of glass and not closer than 1.5 inches from interior faces of glazing frames through full operating ranges of blinds, in accordance with GANA Glazing Manual.
 3. Install mounting and intermediate brackets to prevent deflection of headrails.
 4. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.
- B. Divisions between window blinds are allowed only at mullions of continuous windows or openings where more than one window blind for one opening occurs.

3.3 ADJUSTING

- A. Adjust window blinds to operate free of binding and malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

- A. Prior to Substantial Completion, clean window blind surfaces in accordance with manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and that ensures that window blinds are without damage or deterioration at Substantial Completion.
- C. Prior to Substantial Completion, replace damaged window blinds that cannot be acceptably repaired.

+ + END OF SECTION + +

SECTION 12 50 00

FURNITURE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all furniture Work.
2. Extent of the furniture Work is shown and specified.
3. Types of furniture Work required includes, but is not limited to, the following:
 - a. File Cabinets.
 - b. Desks.
 - c. Chairs.
 - d. Tables.
 - e. Shelving Units
 - f. Workbench
 - g. Miscellaneous Accessories.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the Work that must be installed with the furniture Work.

1.2 QUALITY ASSURANCE

- ###### A. Catalog Standards:
- The use of catalog numbers and the specific requirements set forth in these Specifications are not intended to preclude the use of any other acceptable manufacturer's products which may be equivalent, but are provided for the purpose of establishing a standard of design and quality for materials, construction and workmanship. Some catalog numbers may be void at time of bidding due to catalog revisions. Provide products equal in quality to those specified.

B. Design Criteria: Provide the following:

1. Fabric of 80 percent wool and 20 percent nylon with acrylic latex backing fluorochemically treated for soil and stain repellency, fire retardant treated and mothproofed.
2. Upholstered items shall be capable of being reupholstered without special equipment and using the manufacturer's standard interchangeable reupholstery system.
3. Manufacturers of "or equal" products shall be able to supply exactly the same design, colors, fabrics and textures as the manufacturer specified.

1.3 SUBMITTALS

- A. Action Submittals: Provide the following:
1. Product Data:
 - a. Manufacturer's catalog cuts noting required items and installation instructions for each piece of furniture.
 2. Samples:
 - a. 3-inch by 5-inch sample of all fabric, paint surface and laminate finish and colors.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: Take all necessary precautions to prevent damage to furniture during shipment and delivery. Securely fasten the furniture to the truck to prevent movement or damage during shipment. The ENGINEER shall examine all furniture before and during unloading.
- B. Handling: Carefully handle all furniture to prevent damage. Furniture that is chipped, gouged, dented or otherwise damaged will not be accepted.
- C. Storage of Material: No furniture shall be delivered and stored at the Site until the rooms designated to receive the furniture are completed.

PART 2 - PRODUCTS

2.1 FURNITURE AND ACCESSORIES

- A. Materials:
1. Furniture Schedule: Quantities are identified herein. Provide the following items for each space as scheduled.

Building/Room Name and Number	Item	Quantity	Description
Beardsley Pump Station:			
Control Room 106	Side Chair	Two	Side chair sled base w/ arms – Heavy duty, bariatric seating, fully upholstered w/resin coated frame and wall saver trim. Freelance model #5214 by SitOnIt Seating Company, Inc., Or Approved Equal Upholstery Fabric: Grade 5

Building/Room Name and Number	Item	Quantity	Description
Control Room 106	Desk Chairs	Two	Task Desk chair on 5 star black resin base w/casters. Intensive (I) ergonomic options, fully upholstered seat and back. 26''w x 26''d x 36''h TR2 Task 40I SitOnIt Seating Company, Inc., Or Approved Equal Upholstery Fabric: Grade 5
Control Room 106	Desk	Two	36'' x 72'' Double Pedestal Desk, Center drawer and Return. Drawer slides, desk top grommets, locks and recessed drawer pulls. Series 38000 – Steel base desk with HPL top by The HON Company, Inc., Or Approved Equal Finish: Painted steel w/ laminate top
Control Room 106	Lateral Files	Two	5-drawer high metal lateral file w/std roll out shelves and adjustable hangrails. Flagship Lateral File Series w/ Type R –full radius pulls and locks The HON Company, Inc., Or Approved Equal
Control Room 106	Open Shelving Unit	Two	Open metal, 5 shelf, utility unit 36''w x 72''h x 24''d. Polished chrome, woven wire metal shelving The HON Company, Inc., Or Approved Equal
Garage 102	72'' 6-drawer workbench	One	WG253653 by Global Industrial, Or Approved Equal
Garage 102	Bench vise with swivel base	One	WG534516 6'' Jaw width, 3'' Throat depth vise by Global Industrial, Or Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Uncrate all furniture and inspect for damage. Replace or repair all damaged material.
- B. Provide a secure storage area to keep the furniture protected and in its original condition.
- C. Store in original containers.
- D. Install furniture Work just prior to Final Acceptance.

- E. Completely assemble all furniture items and install, mount, attach or otherwise place the furniture in the locations designated by the ENGINEER.
- F. Final location of all items specified herein will be provided to CONTRACTOR by the ENGINEER after the award of Contract.

3.2 ADJUSTMENT AND CLEANING

- A. Adjust all furniture and leave in good condition.
- B. Protect all furniture with plastic wrapping until Final Acceptance by the OWNER.
- C. Replace all furniture Work damaged or missing at no additional cost to the OWNER until Final Acceptance.

++ END OF SECTION ++

SECTION 22 05 27

PIPE SLEEVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install pipe sleeves, other wall pieces, and escutcheons complete with accessories.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the pipe sleeves Work.

C. Related Sections:

1. Section 03 30 05, Concrete.
2. Section 07 92 00, Joint Sealants.
3. Section 22 11 16, Domestic Water Piping.
4. Section 22 13 16, Sanitary Waste & Vent Piping.
6. Section 22 18 00, Natural Gas Piping System (Plumbing).

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American National Standards Institute, (ANSI).
 - a. ANSI A21.4, Cement-Mortar Lining for Cast-Iron and Ductile Iron Pipe and Fittings.
 - b. ANSI A21.6, Cast-Iron Pipe Centrifugally Cast in Metal Molds.
 - c. ANSI A21.10, Cast-Iron and Ductile Iron Fittings, 2 thru 48-inches in Water.
 - d. ANSI A21.11, Rubber Gasket Joints for Cast-Iron and Ductile Iron Pressure Pipe.
 - e. ANSI A21.15, Flanged Cast-Iron and Ductile Iron.
 - f. ANSI A21.51, Ductile Iron Pipe Centrifugally Cast in Metal Molds.
 - g. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
2. American Society for Testing and Materials, (ASTM).
 - a. ASTM A36 / A36M, Specification for Carbon Structural Steel.
 - b. ASTM A47 / A47M, Specification for Ferritic Malleable Iron Castings.
 - c. ASTM A123 / A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. ASTM A153 / A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel hardware.

- e. ASTM A239, Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles
- f. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- g. ASTM A668 / A668M, Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
- h. ASTM A780 / A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- i. ASTM D520, Standard Specification for Zinc Dust Pigment.
- 3. American Water Works Association, (AWWA).
 - a. AWWA C104, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - b. AWWA C106, Cast-Iron Pipe Centrifugally Cast in Metal Molds.
 - c. AWWA C110, Ductile-Iron and Gray-Iron Fittings for Water.
 - d. AWWA C111, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. AWWA C115, Flanged Ductile-Iron Pipe or Gray-Iron Threaded Flanges.
 - f. AWWA C151, Ductile-Iron Pipe, Centrifugally Cast for Water.
- 4. Military Specification, (MIL).
 - a. MIL-P-21035A, Repair of Galvanized Metal
 - b. MIL-P-26915A, Zinc Dust Primer

1.3 QUALITY ASSURANCE

A. Installers' Qualifications:

- 1. Engage a single installer regularly engaged in pipe sleeves and mechanical seals installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit names and qualifications to ENGINEER.
- 2. Engage a single installer for the entire pipe sleeves and mechanical seals system with undivided responsibility for performance and other requirements.

B. Component Supply and Compatibility:

- 1. Obtain all products included in this Section regardless of the component manufacturer from a single pipe sleeves and mechanical seal manufacturers.
- 2. The pipe sleeves and mechanical seal manufacturers to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
- 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe sleeves and mechanical seal manufacturers.

C. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

- 1. International Building Code, (IBC).

2. American National Standards Institute, (ANSI).
3. American Society of Mechanical Engineers, (ASME).
4. National Fire Protection Association, (NFPA).
5. Underwriters' Laboratories, Incorporated, (UL).
6. Local and State Building Codes and Ordinances.

1.4 SUBMITTALS

- A. Shop Drawings: Submit the following:
1. Manufacturer's literature, illustrations, specifications and engineering data.
 2. Details of installation.
 3. Detailed drawings showing all pipe sleeves and mechanical seals for each piping system. Drawings shall show location, installation and material of all pipe sleeves and mechanical seals.
 4. Other technical data related to the specified material and equipment as requested by ENGINEER.
 5. Installer's Qualifications.
 6. Deviations from Contract Documents.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
- B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 GENERAL REQUIREMENTS

- A. The Contract Documents show the general arrangement and extent of the Work to be completed. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.
- B. The Drawings show an indication of the arrangement of equipment, piping, valves, etc., and are as nearly correct as can be determined in advance of the

actual construction of the Work. Piping, equipment, piping, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.

- C. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case, adequately provide for expansion and circulation and minimize the amount of space required for the same.
- D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.
- E. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others", to complete the systems to the true extent of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All references to galvanizing finish shall mean "Hot-Dipped Galvanized meeting the ASTM A123 / A123M and ASTM A153 / A153M."
 - 1. Materials:
 - a. Bolts: ASTM A 307, Grade A, unless otherwise specified below.
 - b. Forgings: ASTM A 668/A 668M.
 - c. Malleable Iron: ASTM A 47/A 47M.
 - d. Threads: Unified Screw Threads, Class 2A and 2B, ANSI B1.1.
 - e. Structural Steel: ASTM A 36/A 36M.
 - 2. Finish:
 - a. Steel or Iron Items: All galvanized items shall be Hot-Dipped Galvanized meeting ASTM A123/A123M and ASTM A153/A153M.
 - 3. Galvanizing Repair:
 - a. All field cut galvanized sleeves shall be repaired using cold galvanized compound.

2.2 MATERIALS

- A. Pipe Sleeves:

1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown.
 2. Copper Pipe: Use standard weight galvanized steel pipe with mechanical link seals as spacers, unless otherwise shown.
- B. Cast Wall Sleeves:
1. Material: Cast-iron furnished with integral wall collar.
 2. Dimensions: As required for mechanical joint or calked joint pipe to pass through sleeve. Length as required.
- C. Mechanical Seals: Provide link type mechanical seals with adjusting bolts suitable for 20 psi working pressure where shown or required.
1. Manufacturers: Provide products of one of the following:
 - a. Thunderline Corporation, Link-Seals.
 - b. Advance Products & Systems, Inc., Innerlynx.
 - c. The Metraflex Co.
 - d. Or equal.
 2. Materials: Mechanical seals through non-fire rated walls or floors:
 - a. Pressure Plate: Glass reinforced nylon plastic.
 - b. Bolt and Nut: 18-8 stainless steel.
 - c. Sealing Element: EPDM rubber.
 3. Materials: Mechanical seals through fire rated walls or floors; two independent mechanical seal assemblies required for each penetration:
 - a. Pressure Plate: Low carbon steel, zinc galvanized plated or stainless steel.
 - b. Bolt and Nut: Low carbon steel zinc galvanized.
 - c. Sealing Element: Silicone rubber.
 - d. Fire rating: Three-hour.
- D. Wall, Floor and Ceiling Escutcheon Plates:
1. Manufacturers: Provide products of one of the following:
 - a. Bridgeport Plumbing Products, Incorporated.
 - b. Pegasus Manufacturing, Incorporated.
 - c. Or equal.
 2. Bare Pipes Passing Through Walls, Floors and Ceilings in any Room: Provide escutcheon plates of cast brass or stamped steel, chrome plated, hinged with setscrews.
 3. Insulated Pipes Passing Through Walls, Floors and Ceilings in Finished Rooms: Provide plated escutcheon plates of stamped steel or cast brass, chrome plated, hinged with setscrews.
- E. Exterior Walls or Floors: Below grade:
1. Manufacturers: Provide products of one of the following:
 - a. Thunderline Corporation, Century-Line Sleeves.
 - b. Omni Sleeve.
 - c. Or equal.
 2. Type: Thermoplastic sleeve for use in new construction where sleeves are exposed to liquid or on exterior walls or floors exposed to backfill only.

3. Integral reinforcing ribs, anchor and waterstop collar textured surface for adhesion to concrete.
- F. Galvanizing Compound:
1. Type: Field applied cold galvanizing compound for iron and steel (use Low VOC if required by Code).
 2. References:
 - a. MIL-P-26915A / MIL-P-21035A
 - b. ASTM D520 / Des. A239
 - c. ASTM Des. A-780 / Des. B117
 3. Manufacturers: Provide products of one of the following:
 - a. ZRC Worldwide, ZRC / ZRC 221.
 - b. Crown Zinc Galvanize Compound
 - c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
1. Install all items as shown, specified, and as recommended by the manufacturer.
 2. Request instructions from ENGINEER, in writing, when there is a conflict between the manufacturer's recommendations and the Contract Documents.
 3. Present conflicts to ENGINEER, in writing, who will determine corrective measures to be taken.
 4. Do not modify structures to facilitate installation of pipe sleeves, mechanical seals, and accessories, unless specifically approved by ENGINEER.
 5. Installation to conform to requirements of all local and state codes.
 6. Protection: Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.
- B. Pipe Sleeves:
1. Use sleeves wherever pipes pass through walls, partitions, floors and roofs, unless otherwise shown.
 2. All sleeves through floor slabs in finished areas shall extend a maximum of 1/4-inch above finished floor.
 3. Anchor sleeves to concrete and masonry walls as shown or otherwise accepted.
 4. Sleeves through walls shall be flush with wall face.
 5. Calk and seal annular space between pipe and sleeve.
 6. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
 7. All vertical pipes through sleeves shall be installed with Link Seal "Pyro-Pacs" to maintain a minimum 2 hour fire rating between the two fire areas.

8. Size Sleeves to provide annular space as recommended by the mechanical seal manufacturer and as follows:

<u>Pipe Size</u>	<u>Sleeve ID Minus Pipe or Insulation OD</u>
Less than 2-in.	1/2-in. to 3/4-in.
2-in. to 4-in.	3/4-in. to 1-1/4-in.
6-in. to 12-in.	1-1/4-in. to 2-in.

9. For mechanical link seals, size sleeves to provide space required to suit link type seals provided.
10. Do not install sleeves and pipes through structural members unless specifically required due to coordination or obstructions, each sleeve condition shall be submitted for approval.

3.2 FIELD QUALITY CONTROL

A. Inspection:

1. Examine areas to receive pipe sleeves, mechanical seals, escutcheons and accessories for:
 - a. Defects that adversely affect execution and quality of the Work.
 - b. Deviations beyond allowable tolerances for pipe sleeves, mechanical seals, escutcheons and accessories.
 - c. Start the Work only when conditions are satisfactory.
2. The ENGINEER reserves the right to reject or authorize replacement of pipe sleeves, mechanical seals, escutcheons and accessories found to be defective.

3.3 ADJUSTING AND CLEANING

A. Adjusting:

1. Adjust all materials for proper settings.

B. Cleaning:

1. Thoroughly clean all pipe sleeves, mechanical seals, escutcheons and accessories prior to installation.
2. Remove all dirt, rust, dust, etc. from all pipe sleeves, mechanical seals and escutcheons in preparation for required painting.
3. Remove and dispose of all debris and waste from the Site resulting from installation.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install hangers and supports complete with accessories for plumbing piping and equipment.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the hangers and supports for plumbing piping and equipment Work.
- C. Related Sections:
 - 1. Section 05 12 00, Structural Steel Framing.
 - 2. Section 05 50 05, Anchor Systems.
 - 3. Section 05 50 13, Miscellaneous Metal Fabrications.
 - 4. Section 09 91 00, Painting.
 - 5. Section 22 11 16, Domestic Water Piping.
 - 6. Section 22 13 16, Sanitary Waste & Vent Piping.
 - 7. Section 22 18 00, Natural Gas Piping System (Plumbing).

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - a. ANSI B1.1, Unified Inch Screw Threads. (ASME B1.1).
 - 2. American Society for Testing and Materials, (ASTM).
 - a. ASTM A36 / A36M, Specification for Carbon Structural Steel.
 - b. ASTM A47 / A47M, Specification for Ferritic Malleable Iron Castings.
 - c. ASTM A123 / A123M – 12, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. ASTM A153 / A153M – 09, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel hardware.
 - e. ASTM A239, Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles
 - f. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - g. ASTM A575, Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.

- h. ASTM A668 / A668M, Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
- i. ASTM A780 / A780M - 09, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- j. ASTM B117 - 11, Standard Practice for Operating Salt Spray (Fog) Apparatus.
- k. ASTM D520, Standard Specification for Zinc Dust Pigment.
- 3. Federal Specifications, (FS).
 - a. FS WW-H-171, Hangers and Supports, Pipe.
- 4. Manufacturer's Standardization Society, (MSS).
 - a. MSS SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
 - c. MSS SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.
 - d. MSS SP 90, Guidelines on Terminology for Pipe Hangers and Supports.
- 5. Military Specification, (MIL).
 - a. MIL-P-21035A, Repair of Galvanized Metal
 - b. MIL-P-26915A, Zinc Dust Primer

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications:
 - 1. Engage a single installer regularly engaged in hangers and supports installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
 - 2. Engage a single installer for the entire plumbing pipe and equipment hangers and supports system with undivided responsibility for performance and other requirements.
- B. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. American National Standards Institute, (ANSI).
 - 2. American Society of Mechanical Engineers, (ASME).
 - 3. National Fire Protection Association, (NFPA).
 - 4. Underwriters' Laboratories, Incorporated, (UL).
 - 5. Local and State Building Codes and Ordinances.
 - 6. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.
- C. Component Supply and Compatibility:
 - 1. Obtain all products included in this Section regardless of the component manufacturer from a single plumbing pipe and equipment hangers and supports manufacturer.

2. The plumbing piping and equipment hangers and supports manufacturer shall review and approve all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the plumbing piping and equipment hangers and supports manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Details of installation.
 - b. Detailed drawings showing all hangers and supports for each piping system. Drawings shall show location, installation, material, loads, forces, stresses and deflections of all hangers and supports.
 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications and engineering data.
 - b. Other technical data related to the specified material and equipment as requested by ENGINEER.
- B. Informational Submittals: Submit the following:
 1. Qualifications Statements:
 - a. Installer's Qualifications.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
- B. Storage and Protection:
 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 GENERAL REQUIREMENTS

- A. The Contract Documents show the general arrangement and extent of the Work to be completed. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.
- B. The Drawings show an indication of the arrangement of equipment, piping, valves, etc., and are as nearly correct as can be determined in advance of the actual construction of the Work. Piping, equipment, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.
- C. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case, adequately provide for expansion and circulation and minimize the amount of space required for the same.
- D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.
- E. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others", to complete the systems to the true extent of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Components of hangers and supports shall conform to the following:
 - 1. Materials:
 - a. Bolts: ASTM A 307, Grade A, unless otherwise specified below.
 - b. Forgings: ASTM A 668/A 668M.
 - c. Malleable Iron: ASTM A 47/A 47M.
 - d. Rods and Bars: ASTM A 575.
 - e. Threads: Unified Screw Threads, Class 2A and 2B, ANSI B1.1.
 - f. Structural Steel: ASTM A 36/A 36M.
 - 2. Finish:

- a. Steel or Malleable Iron Items: Hot-Dipped Galvanized (ASTM A123 / A123M – 12 and ASTM A153 / A153M – 09).
 - b. Steel or Malleable Iron Materials Used for the Support of Uninsulated Copper Piping: Copper plated.
 - c. Framing Members and Fittings: Dip painted with corrosion resistive primer as specified in Section 09 91 00, Painting.
 - d. All hangers, rods, bolts, nuts, inserts, washers located in the corrosive areas (Wet Well) shall be Type 316 stainless steel.
- B. Pipe Attachments: The following types of pipe attachments shall be considered acceptable:
1. Adjustable Steel Clevis: FS WW-H-171E, Type 1.
 2. Steel Double Bolt Pipe Clamp: FS WW-H-171E, Type 3.
 3. Steel Pipe Clamp: FS WW-H-171E, Type 4.
 4. Adjustable Swivel Pipe Ring: FS WW-H-171E, Type 6.
 5. Adjustable Steel Band Hanger: FS WW-H-171E, Type 7.
 6. Riser Clamp: FS WW-H-171E, Type 8.
 7. Light-Duty Clevis Hanger: FS WW-H-171E, Type 12.
 8. Long Clips: FS WW-H-171E, Type 26.
 9. Offset J-Hooks: FS WW-H-171E, Type 27.
 10. Steel Pipe Covering Protection Saddle: FS WW-H-171E, Type 40A.
 11. Insulation Protection Shield: FS WW-H-171E, Type 41.
 12. Pipe Saddle Support: FS WW-H-171E, Type 37.
 13. Pipe Stanchion Saddle: FS WW-H-171E, Type 38.
 14. Pipe Saddle Support with Base: FS WW-H-171E, Type 36.
 15. Adjustable Roller Hanger: FS WW-H-171E, Type 42.
- C. Structural Attachments: The following types of structural attachments shall be considered acceptable:
1. Side Beam Clamp: FS WW-H-171E, Type 20.
 2. Center I-Beam Clamp: FS WW-H-171E, Type 21.
 3. Welded Steel Bracket: FS WW-H-171E, Types 32 and 33.
 4. Side Beam Bracket: FS WW-H-171E, Type 35.
 5. Malleable Iron Concrete Insert with Hot-Dipped Galvanized Finish (ASTM A123 / A123M – 12, ASTM A153 / A153M – 09): FS WW-H-171E, Type 18. The use of steel concrete inserts is prohibited and NOT acceptable.
- D. Hanger Rod Attachments: Use as required to complete assembly:
1. Forged Steel Clevis: FS WW-H-171E, Type 14.
 2. Adjustable Turnbuckle: FS WW-H-171E, Type 15.
 3. Forged Steel Welders Eye Nut: FS WW-H-171E, Type 17.
 4. Finish: Hot-Dipped Galvanized, meeting the requirements of ASTM A123 / A123M – 12 and ASTM A153 / A153M – 09, unless otherwise specified or as shown.
- E. Expansion Joints:
1. Manufacturers: Provide products of one of the following:
 - a. Flexonics Division, Universal Oil Products Company.

- b. Anaconda Metal Hose Division, Anaconda American Brass Company.
 - c. Or equal.
 - 2. 2-1/2-inch and Smaller Copper Tubing:
 - a. Construction: Two-ply phosphor bronze seamless bellows.
 - b. Shrouds: Brass protective shrouds.
 - c. End Connections: Male and female solder end fittings or screwed ends with adaptors for screwed to sweat ends.
 - 3. 3-inch and Larger:
 - a. Construction: Free flexing expansion joints with stainless steel corrugated members.
 - b. End Connections: Welded ends with flanges.
- F. Alignment Guides:
 - 1. Type: Semi-steel spider with four guiding fingers and guiding cylinder with base.
 - 2. Manufacturers: Provide products of one of the following:
 - a. Flexonics Division, Universal Oil Products Company.
 - b. Anaconda Metal Hose Division, Anaconda American Brass Company.
 - c. Or equal.
- G. Connection Bolts: Materials shall be as specified in other Sections of these Specifications or as shown. Where materials are not specified or shown, they shall be of Type 304 stainless steel with Monel nuts.
- H. Galvanizing Compound:
 - 1. Type: Field applied cold galvanizing compound for iron and steel (use Low VOC if required by Code).
 - 2. References:
 - a. MIL-P-26915A / MIL-P-21035A
 - b. ASTM D520 / Des. A239
 - c. ASTM Des. A-780 / Des. B117
 - 3. Manufacturers: Provide products of one of the following:
 - a. ZRC Worldwide, ZRC / ZRC 221.
 - b. Crown Zinc Galvanize Compound
 - c. Or equal.
- I. CONTRACTOR shall furnish and install all necessary supports, angle iron stands, miscellaneous steel, inserts, anchor bolts and hangers required for all equipment furnished under this Contract, unless otherwise noted. All supports shall meet the requirements of the applicable Sections of Division 05, Metals. All non-corrosive areas shall be hot-dipped galvanized (ASTM A123 / A123M – 12 and ASTM A153 / A153M – 09). All corrosive areas shall be 316 stainless steel.

2.2 PAINTING

- A. All pipe hangers, supports and restraints shall be painted as required in accordance with the requirements of Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install all items as shown, specified, and as recommended by the manufacturer.
2. Request instructions from ENGINEER, in writing, when there is a conflict between the manufacturer's recommendations and the Contract Documents.
3. Present conflicts to ENGINEER, in writing, who will determine corrective measures to be taken.
4. Do not modify structures to facilitate installation of pipe hangers, supports and restraints, unless specifically approved by ENGINEER.
5. Installation to conform to requirements of all local and state codes.
6. Protection: Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.2 FIELD QUALITY CONTROL

A. Inspection:

1. Examine areas to receive plumbing piping and equipment hangers and supports and accessories for:
 - a. Defects that adversely affect execution and quality of the Work.
 - b. Deviations beyond allowable tolerances for pipe hangers, supports and restraints and accessories.
 - c. Start the Work only when conditions are satisfactory.
2. The ENGINEER reserves the right to reject or authorize replacement of pipe hangers, supports and restraints and accessories found to defective.

3.3 ADJUSTING AND CLEANING

A. Adjusting:

1. Adjust all materials for proper settings.

B. Cleaning:

1. Thoroughly clean all pipe hangers, supports and restraints and accessories prior to installation.
2. Remove all dirt, rust, dust, etc. from all pipe hangers, supports and restraints in preparation for required painting.
3. Remove and dispose of all debris and waste from the Site resulting from installation.

3.4 MATERIAL SCHEDULES

A. Hangers, Supports and Restraints for Horizontal Piping:

1. Space supports and hangers for all piping no farther apart than shown below, unless otherwise shown:

- a. Copper Tube:
 - 1) All Pipes: 6 feet-0 inch on center.
- b. Steel Pipe:
 - 1) Pipes up to 1-inch: 6 feet-0 inch on center.
 - 2) Pipes 1-1/4-inch to 6-inch: 8 feet-0 inch on center.
- c. Cast-Iron Pipe:
 - 1) Two supports per length.
- d. Plastic Pipe:
 - 1) 3 feet-0 inch on center for all sizes, unless otherwise recommended by manufacturer for 100°F ambient temperature.

B Hanger Rods: Size hanger rods according to the schedule below, unless noted otherwise.

<u>Nominal Pipe (Inches)</u>	<u>Rod Diameter (Inches)</u>
1/2 through 2	3/8
2-1/2 through 3-1/2	1/2
4 through 5	5/8
6	3/4

C. Supports for Vertical Piping:

- 1. Provide riser clamp placed under hub, fitting or coupling with approved solid bearing on steel sleeve at each floor level.
- 2. Where riser clamps are used with plastic piping they shall be modified so as not to exert any compressive forces on the pipe.
- 3. Support spacing shall not exceed code requirements.
- 4. Piping support intervals shall not exceed those listed in Paragraph 3.4.A., above.
- 5. Additional supports shall be placed immediately adjacent to any change in piping direction, and on both sides of valves and couplings.
- 6. Accurately locate inserts for hanger rods in forms before concrete is placed.
- 7. Use Type 304 stainless steel expansion anchor assemblies of the capsule polyester resin adhesive type and only to support rods, hangers and brackets for piping 1-inch and smaller no other type will be considered and only if the expansion anchors are designed to carry 100 percent of the full load, hanger, and/or bracket and pipe load.

D. Supports for water meters and backflow preventers: Provide pipe saddle supports with base anchored to floor.

E. Structural members shall conform to Section 05 12 00, Structural Steel Framing.

F. Anchor bolts, expansion anchors and concrete inserts shall conform to Section 05 05 33, Anchor Systems.

- G. Miscellaneous metal fabrications shall conform to Section 05 50 13, Miscellaneous Metal Fabrications.
- H. Allow clearances for expansion and contraction of piping.
- I. Anchors shall be designed to prevent any pipe movement at pipe anchorage points. Anchors shall be securely fastened to the construction directly or indirectly through structural framing:
 - 1. Piping 2-1/2-inches and Smaller: Anchor horizontal runs over 50 feet to midpoint to allow expansion toward expansion compensators (anchor intervals shall not exceed 30 feet) or elbows.
 - 2. Piping 3-inches and Larger: Anchor horizontal runs over 100 feet at mid-points to force expansion toward expansion compensators.
 - 3. Provide alignment guides in accordance with expansion compensator manufacturer recommendations.
- J. Provide expansion compensators where necessary to absorb expansion and contraction in heating lines and as follows:
 - 1. Thirty feet on center of copper piping.
 - 2. Fifty feet on center of steel piping.
- K. Locate first set of alignment guides within four pipe diameters of the anchor or expansion compensator, the second set of pipe alignment guides shall be located within fourteen pipe diameters of the first guides.
- L. All hangers, rods, supports, hardware, etc. not located in corrosive areas shall be hot-dipped galvanized, meeting the requirements of ASTM A123 / A123M – 12 and ASTM A153 / A153M – 09, unless otherwise specified or as shown. All hangers, rods, supports, hardware, etc. located in corrosive areas shall be 316 Stainless Steel. Corrosive areas shall include Wet Well and exterior areas.

+ + END OF SECTION + +

++NO TEXT ON THIS PAGE++

SECTION 22 05 93

DISINFECTION OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as specified, and required to complete all plumbing system disinfection Work.
- B. Coordination:
 - 1. Review the extent of plumbing systems to be disinfected to ensure that all items have been installed in sufficient time to allow the disinfection Work to proceed.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 22 11 16, Domestic Water Piping.
 - 3. Section 22 40 00, Plumbing Fixtures.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - 2. American Society for Testing and Materials, (ASTM).
 - 3. American Water Works Association, (AWWA).
 - a. AWWA C651, Disinfecting Water Mains.
 - b. AWWA C652, Disinfection Water Storage Facilities and Equipment.

1.3 QUALITY ASSURANCE

- A. Contractor's Qualifications:
 - 1. Contractor regularly engaged in potable water piping and equipment disinfections and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
- B. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. American National Standards Institute, (ANSI).
 - 2. Local and State Building Codes and Ordinances.
 - 3. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Testing Plans, Procedures, and Testing Limitations:
 - a. Description of the forms of chlorine, dosages, and proposed methods of disinfection.
- B. Informational Submittals: Submit the following:
 - 1. Site Quality Control Submittals:
 - a. Bacteriological test reports formatted according to requirements of authorities having jurisdiction.
 - 2. Qualification Statements:
 - a. Contractor's Qualifications.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide all necessary equipment and materials, including chemicals, to perform the disinfecting operations.

PART 3 - EXECUTION

3.1 DISINFECTION

- A. General:
 - 1. Pumps, hydrants, and other water handling equipment items that are part of the potable water distribution system shall be disinfected in the same manner as described herein for the pipelines.
 - 2. The method to be followed shall be that prescribed by the local authorities or in accordance with the procedures recommended by AWWA C651 and C652, except as specified below.
 - 3. Before application of chlorine, flush the piping system at a velocity of not less than 2.5 feet per second. Do not flush the system if the tablet method, as specified in the above standard is used.
 - 4. After the applicable retention period, flush the system using potable water.

3.2 FIELD QUALITY CONTROL

- A. Testing: Perform bacteriological tests in accordance with AWWA C651.

++ END OF SECTION ++

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install plumbing piping insulation complete with accessories.
2. The Contract Documents show the general arrangement and extent of the Work under this Section. Exact location and arrangement of all parts of the Work under this Section will be determined as the Work progresses. Exact location of the Work under this Section will be governed in part by building layout and conditions at the Site.
3. The Drawings do not show all offsets, fittings, accessories and details, for which insulation Work may be required. After examining the Contract Documents and conditions at the Site for conditions that affect the plumbing piping insulation Work, shall arrange the Work accordingly, providing all items required for such conditions that are not included under other Sections or other contracts to complete the systems.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before plumbing piping insulation Work.

C. Related Sections:

1. Section 10 14 00, Signage.
2. Section 22 11 16, Domestic Water Piping.
3. Section 22 13 16, Sanitary Waste and Vent Piping.
4. Section 22 40 00, Plumbing Fixtures.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI A117.1, Guidelines for Accessible and Usable Buildings and Facilities.
2. ASTM C449/C449M, Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finish Cement.
3. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
4. Federal Specification (FS) SS-C-160, Cement, Insulation, Thermal.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer:
 - a. Engage installer regularly engaged in plumbing piping insulation installation and with experience installing the types of materials required; and employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
 - b. Engage a single plumbing piping insulation installer for entire piping insulation system, with undivided responsibility for performance and other requirements.
- B. Component Supply and Compatibility:
 - 1. Obtain all products included in this Section regardless of component manufacturer, from a single piping insulation Supplier.
 - 2. Plumbing piping insulation Supplier shall review and approve or prepare all Shop Drawings and other submittals for components furnished under this Section.
 - 3. Components shall be suitable for specified service conditions and shall be integrated into overall assembly by plumbing piping insulation Supplier.
- C. Regulatory Requirements: Comply with the following.
 - 1. Americans with Disabilities Act (ADA).
 - 2. Applicable building codes and ordinances as listed in Division 1, Coordination, Field Engineering, and Regulatory Requirements.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, and engineering data.
 - b. Other technical data related to specified materials as requested by ENGINEER.
- B. Informational Submittals: Submit the following:
 - 1. Manufacturer's Instructions:
 - a. Manufacturer's recommended installation instructions.
 - 2. Qualifications Statements:
 - a. Installer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work.

2. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
 3. Conform to Division 1, Materials and Equipment.
- B. Storage and Protection:
1. Keep all products off ground using pallets, platforms, or other supports, in covered storage. Protect materials from damage and deterioration.
 2. Prevent condensation in materials and packaging in accordance with manufacturer's recommendations for long-term storage
 3. Conform to Division 1, Materials and Equipment.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Fiberglass Insulation:
1. Products and Manufacturers: Provide one of the following:
 - a. Fiberglass 25ASJ/SSL, by Owens-Corning Fiberglass Corporation.
 - b. Certain Teed Snap-On ASJ-SSL, by Certain Teed Products Corporation.
 - c. Or equal.
 2. Type: Heavy-density sectional pipe insulation with vapor barrier with self-sealing lap.
 3. Thermal Conductivity: 0.22 Btu-inch per hour per square foot per degree F at 150 degrees F mean temperature.
 4. Fire Hazard Classification:
 - a. Flame Spread: 25.
 - b. Fuel Contributed: 50.
 - c. Smoke Developed: 50.
 5. Density: Three pounds per cubic foot (pcf) minimum.
 6. Fittings: Molded fiberglass.
 7. Jointing Materials: Manufacturer's recommended adhesives and tape.
 8. Valve Insulation: Miter cut nesting size covering segments of same thickness as pipeline, for insulation of valves.
- B. Calcium Silicate Insulation at Insulation Protection Shields:
1. Products and Manufacturers: Provide one of the following:
 - a. Kaylo 10, by Owens-Corning Fiberglass Corporation.
 - b. Thermo 12, by Johns-Manville.
 - c. Or equal.
 2. Type: Calcium silicate pipe insulation.
 3. Thermal Conductivity: 0.40 Btu-inch per hour per square foot per degree F at 200 degrees F mean temperature.
 4. Fire Hazard Classification:
 - a. Flame Spread: Zero.
 - b. Smoke Developed: Zero.

5. Density: 14 pounds per cubic foot (pcf).
6. Compressive Strength: 140 psi.
7. Cut insulation 0.5-inch longer than insulation shield upon which it rests.

C. Pipe Jacketing and Valve Covers:

1. Manufacturers: Provide products of one of the following:
 - a. Childers Product Company.
 - b. Certain-Teed Products Corporation.
 - c. Zeston PVC Products/Schuller International, Inc.
 - d. Or equal.
2. Weatherproof Jacket (for insulated piping and appurtenances located outdoors, and where shown or indicated):
 - a. Type: Smooth-embossed, Type 316 stainless steel jacket.
 - b. Thickness: 0.016 inches.
 - c. Moisture Barrier: Polycraft.
 - d. Fastening: Pre-formed "Z"-lock seam with two-inch butt strap with waterproof sealant.
 - e. Bands: 1/2-inch Type 316 stainless steel bands with wing seals.
 - f. Fittings: Pre-fabricated Type 316 stainless steel fittings, 0.016-inch thickness.
3. PVC Jacketing (for insulated piping and appurtenances located indoors, unless otherwise shown or indicated):
 - a. 25/50 PVC, conforming to ASTM D1784, Class 16354-C and C-585
 - b. Thickness: 20 mils.
 - c. Color: White.
 - d. Finish: Glossy.
 - e. Temperature: Suitable for 150 degrees F, minimum.

D. Insulating Cement:

1. Products and Manufacturers: Provide one of the following:
 - a. Therm Kote 1, by Ryder Sales.
 - b. Smooth Kote, by Insulco Industries, Inc.
 - c. Or equal.
2. Type: Asbestos-free, hydraulic setting refractory type insulating cement, non-corrosive to ferrous metals.
3. References:
 - a. ASTM C449/C449M.
 - b. FS SS-C-160, Type 111 GRF.

E. Handicapped Lavatory Trim Insulation:

1. Products and Manufacturers: Provide one of the following:
 - a. IPS Corporation, Truebro LavGuard 2.
 - b. Pro Wrap, by McGuire Manufacturing Company, Inc.
 - c. Or equal.
2. Type: Flexible vinyl insulation for waste, traps, hot and cold water supplies.
3. References:
 - a. ADA Article 4.19.4.
 - b. ANSI A117.1.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Piping systems to be insulated and associated insulation thicknesses are specified in the schedule at the end of this Section.
 - 2. Thoroughly clean all piping, insulation, and accessories prior to installation.
 - 3. Remove from piping all dirt, rust, dust, and other materials detrimental to proper installation of insulation.
 - 4. Install items as shown, specified, and as recommended by manufacturer.
 - 5. Request interpretation from ENGINEER if there is conflict between manufacturer's recommendations and the Contract Documents.
 - 6. Do not modify structures to facilitate installation of piping insulation unless approved by ENGINEER.
 - 7. Installation of plumbing piping insulation shall conform to Laws and Regulations.
 - 8. Surfaces of piping, valves, and fittings shall be clean and dry before applying insulation.
 - 9. Install piping insulation after associated piping system has been successfully tested.
 - 10. Provide high-density insulation pipe support inserts at each hanger and shield extending halfway up the pipe insulation cover and extending along pipe at least six inches on each side of hanger. Securely fasten shield with pipe straps at each end. Insulate pipe anchors adequately to prevent moisture condensation problems.
 - 11. Cover insulated surfaces of outdoor piping with stainless steel jacketing neatly fitted and firmly secured. Lap the seams at least two inches. Apply over vapor barrier, where applicable.
 - 12. Protection: Piping insulation materials applied each day shall have vapor barrier applied the same day and exposed ends shall be temporarily protected with moisture barrier and sealed to pipe.

3.3 ADJUSTING

- A. Adjusting:
 - 1. Adjust or replace, as required, poorly-fitted joints.

3.4 SCHEDULES

- A. Piping Insulation Schedule: Insulate plumbing piping as specified below, unless otherwise specified or shown:
 - 1. All hot, cold, tempered and tepid water piping 2.5-inch diameter and smaller shall be insulated and jacketed: Insulation thickness shall be one-inch minimum.
 - 2. All hot, cold, tempered and tepid water piping three-inch diameter and larger shall be insulated and jacketed: Insulation thickness shall be 1.5-inch minimum.
 - 3. All horizontal storm drainage, indirect waste and condensate drain piping shall be insulated and jacketed: Insulation thickness shall be one-inch minimum.
 - 4. Insulate plumbing piping below handicapped lavatories. Thickness to be manufacturer's standard thickness as specified in Part 2 of this Section.

+ + END OF SECTION + +

SECTION 22 10 53

INSTALLATION OF PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install plumbing piping systems complete with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the installation of plumbing piping Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 22 11 16, Domestic Water Piping.
 - 3. Section 22 13 16, Sanitary Waste and Vent Piping.
 - 4. Section 22 18 00, Natural Gas Piping System (Plumbing).

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - a. ANSI B13.1, Code for Pressure Piping.
 - b. ANSI B31.1, Power Piping.
 - 2. American Society for Testing and Materials, (ASTM).
 - 3. American Welding Society, (AWS).
 - a. AWS D10.9, Welding Procedures and Welders for Piping and Tubing.
 - 4. Institute of Electrical and Electronic Engineers, (IEEE).
 - 5. National Electrical Code, (NEC).
 - 6. National Electrical Manufacturers' Association, (NEMA).
 - 7. National Fire Protection Association, (NFPA).
 - 8. Underwriters' Laboratories, Incorporated, (UL).

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications:
 - 1. Engage a single installer regularly engaged in plumbing piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.

2. Engage a single installer for the entire plumbing piping system with undivided responsibility for performance and other requirements.
- B. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. American National Standards Institute, (ANSI).
 2. Institute of Electrical and Electronic Engineers, (IEEE).
 3. National Electrical Code, (NEC).
 4. National Electrical Manufacturers' Association, (NEMA).
 5. National Fire Protection Association, (NFPA).
 6. Underwriters' Laboratories, Incorporated, (UL).
 7. Local and State Building Codes and Ordinances.
 8. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.
- C. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single installation of plumbing piping manufacturer.
 2. The installation of plumbing piping manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the installation of plumbing piping manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. 1/4-inch scale piping layouts, dimensioned to show length of piping runs, pipe sizes, support spacing and expansion provisions.
 - b. Details of installation, including piping supports.
 - c. Submit pipe schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.
 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications and engineering data.
 - b. Pipe and fittings.
 - c. Valves.
 - d. Flexible connections.
 - e. Other technical data related to the specified material and equipment as requested by ENGINEER.
 - f. Gasket material.
- B. Informational Submittals: Submit the following:
1. Qualifications Statements:
 - a. Installer's qualifications.

- C. Closeout Submittals: Submit the following:
 - 1. Record Drawings:
 - a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the piping Work submit CADD drawings showing the actual in-place installation of all piping and equipment installed under this Section at a scale satisfactory to the OWNER. The Record Drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the piping systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 GENERAL REQUIREMENTS

- A. The Contract Documents show the general arrangement and extent of the Work to be completed. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.
- B. The Drawings show an indication of the arrangement of equipment, piping, valves, etc., and are as nearly correct as can be determined in advance of the

actual construction of the Work. The piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.

- C. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged as to fully and best suit the requirements of each particular case, adequately provide for expansion and perfect circulation and minimize the amount of space required for the same.
- D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by ENGINEER.
- E. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others," to complete the systems to the true extent of the Contract Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Materials for piping system shall be specified under applicable Sections of Division 22, Plumbing.

2.2 PAINTING

- A. All equipment and accessories shall be painted in accordance with the requirements of Section 09 91 00, Painting.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install all items as shown, specified, and as recommended by the manufacturer.
 - 2. Request instructions from ENGINEER, in writing, when there is a conflict between the manufacturer's recommendations and the Contract Documents.

3. Present conflicts to ENGINEER, in writing, who will determine corrective measures to be taken.
4. Do not modify structures to facilitate installation of piping, unless specifically approved by ENGINEER.
5. Installation to conform to requirements of all local and state codes.
6. All connections between ferrous and non-ferrous piping materials shall be made with dielectric couplings.
7. Wherever changes in sizes of piping occur, changes shall be made with reducing fittings. The use of bushings is not permitted unless otherwise shown.
8. All pipes passing through ceilings, floors and walls in finished rooms, and all supplies to fixtures shall have escutcheon plates.
9. Provide necessary pipe hangers and supports including seismic restraints as required by the building code.
10. Provide shutoff valve, located for easy access, to each piece of equipment furnished.
11. Properly plug or cap the open ends of all piping at the end of each day's Work or other stopping point through construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.
12. Provide drip pans below any plumbing piping passing over electrical panels or motor control centers. Drip pans shall be hot-dipped galvanized steel, 12-inch wider than the pipe it serves, 1-1/2-inch high lip all around and provided with a 1-inch drain line to spill to a drain outside of the protected area or to outside of the building.

3.2 FIELD QUALITY CONTROL

A. Field Tests:

1. Fill all systems and fully test all equipment, valves, piping, etc. in operation.
2. Check for excessive vibration while all systems are operating.
3. Installed systems and components will not be released to OWNER unless all systems have been tested and approved by the ENGINEER.

B. Inspection:

1. Examine areas to receive piping, valves and accessories for:
 - a. Defects that adversely affect execution and quality of the Work.
 - b. Deviations beyond allowable tolerances for piping, valves and accessories.
 - c. Start the Work only when conditions are satisfactory.
2. The ENGINEER reserves the right to reject or authorize replacement of piping and accessories found to be defective.

3.3 ADJUSTING AND CLEANING

A. Adjusting:

1. While system is operable, balance all equipment, valves, etc. to achieve design conditions.

B. Cleaning:

1. Thoroughly clean all piping, fittings, valves, and accessories prior to installation.
2. Remove all dirt, rust, dust, etc. from piping in preparation for painting.
3. Remove and dispose of all debris and waste from the Site resulting from installation.

3.4 MATERIAL SCHEDULES

- A. Material Schedule shall be as specified under applicable Sections of Division 22, Plumbing.

++ END OF SECTION ++

SECTION 22 10 63

TESTING OF PLUMBING PIPING SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to complete all testing of the plumbing piping systems.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the testing of plumbing piping systems Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 22 11 16, Domestic Water Piping.
 - 3. Section 22 13 16, Sanitary Waste and Vent Piping.
 - 4. Section 22 18 00, Natural Gas Piping System (Plumbing).

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - 2. American Society for Testing and Materials, (ASTM).
 - 3. Institute of Electrical and Electronics Engineers, (IEEE).
 - 4. National Electrical Code, (NEC).
 - 5. National Electrical Manufacturers' Association, (NEMA).
 - 6. National Fire Protection Association, (NFPA).
 - a. NFPA 54, National Fuel Gas Code.
 - b. NFPA 99, Standard for Health Care Facilities.
 - 7. Underwriters' Laboratories, Incorporated, (UL).

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications:
 - 1. Contractor regularly engaged in testing of plumbing piping systems and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
- B. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. American National Standards Institute, (ANSI).

2. National Electrical Code, (NEC).
3. National Fire Protection Association, (NFPA).
4. Underwriters' Laboratories, Incorporated, (UL).
5. Local and State Building Codes and Ordinances.
6. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Product Data:
 - a. Submit manufacturer's literature and samples for the valve tags.
 2. Testing Plans, Procedures, and Testing Limitations:
 - a. Description of proposed testing method, procedures, and apparatus to the ENGINEER for approval at least 48 hours in advance of testing.
- B. Informational Submittals: Submit the following:
 1. Site Quality Control Submittals:
 - a. Submit a test report for each test to the ENGINEER certifying the test pressure, duration of test, and test performance of all installed piping.
 2. Qualifications Statements:
 - a. Installer's qualifications.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Provide all necessary equipment and materials, including gages and pumps, to perform the testing operations.

2.2 VALVE TAGS

- A. Manufacturers: Provide products of one of the following:
 1. Seton Name Plate Corporation.
 2. New York Stencil Works.
 3. Or equal.
- B. Construction:
 1. Material: Brass.
 2. Size: 1-1/2-inch diameter.
 3. Chain: Brass.
 4. Lettering Size: 1/4-inch black filled letters over 1/2-inch high black filled numbers.
- C. Legend:
 1. HW - Hot Water.
 2. CW - Cold Water.

3. G - Gas.
4. TW - Tepid Water.
5. SAN – Sanitary.
6. SD – Storm.

2.3 Valve Charts

- A. General:
 1. Two required; 1/8-inch sheet acrylic in 8-1/2 by 11-inch extruded aluminum frame.
 2. Charts: Typed or inked on mylar with the following information for each valve.
 - a. Valve identification number.
 - b. Valve location.
 - c. Valve use.
 - d. Valve size.
 - e. Manufacturer's name and model number.
 3. Submit sample valve tag with lettering.

PART 3 – EXECUTION

3.1 GENERAL

- A. Conduct water, air and smoke tests as required, on all piping systems as specified below.
- B. Conduct all tests in the presence of, and in a manner approved by ENGINEER, all state and local authorities having jurisdiction. Repeat test for these authorities if requested by them.
- C. Repair and retest all lines, which do not pass the tests as specified herein.
- D. Inspect all valves, joints, and specialties for tightness and for proper operation while under test pressure.
- E. Properly plug or cap the open ends of all piping at the end of each day's Work or other stopping point through the testing. Piping shall be tightly covered and protected against contamination.

3.2 FIELD QUALITY CONTROL

- A. Water Tests:
 1. Drainage and Vent system piping:
 - a. Perform tests either on the entire system or on successive sections of the system.
 - b. Tightly close all openings, except the highest opening of the system or section to be tested.

- c. Fill the system or section with water to the point of overflow.
 - d. Test with a head of at least ten feet of water, except for the uppermost ten feet of the system.
 - e. Allow water to stand in the system for at least 15 minutes before inspecting.
 - f. Inspect the system or section for leaks, and repair any leaks found.
2. Water Piping:
- a. Water piping shall be tested and proved tight under a pressure not less than 1-1/2 times the working pressure under which it is to be used, but not less than 100 psig for 30 minutes with no loss of pressure.
 - b. Potable water shall be used for testing potable water systems. Non-potable water shall be used for testing non-potable water systems.
- B. Air Tests:
1. Attach air compressor testing apparatus to any suitable opening after closing all other inlets and outlets. Force dehydrated oil-less compressed air, pressure dew point -40°F, into system until there is a uniform gage pressure without the introduction of additional air. Below is a list of required gage pressures:
 - a. Drainage and Vent Piping (substitute for water test): Five psi for 15 minutes.
 - b. Vacuum System Piping: Test in accordance with the requirements of NFPA 99.
 - c. Natural Gas Piping:
 - 1) All gas piping shall be tested under a pressure not less than 100 psig for a four-hour duration, regardless of working pressure. Duration time period to be measured after stabilization of the testing medium.
 - 2) All joints, fittings valves and other potential leak sources shall be swabbed with a leak detecting solution.
 - 3) A calibrated pressure gage having maximum increments of two psi shall be used.
 - 4) Only temporary weld-end dished-head caps or threaded-end caps, swell plugs or compression end caps (maximum 2-inch) are to be installed during pressure test operations.
 - 5) No compression couplings larger than 2-inches shall be included in the pressure test inside buildings pull-out from thrust forces. All piping shall be securely anchored or blocked to prevent movement or blowouts.
 - 6) Do not include meter, regulator and final service tee at main in leakage test. This equipment should be leak tested at service line pressure.
 - 7) All gas distribution piping shall be pressure tested in accordance with the requirements of the local municipal authorities and the local utility company, after compliance with the testing procedures set forth in this Section are met.

C. Smoke Tests:

1. Finished Plumbing: Final test for gas and water tightness of the completed drainage and vent system:
 - a. Fill all traps with water.
 - b. Introduce a pungent thick smoke, produced by one or more smoke machines, into the system.
 - c. When the smoke appears at stack openings on the roof, close the system.
 - d. Maintain a pressure in the system equivalent to a 1-inch water column for the period of the inspection.
 - e. Inspect the system for leaks and repair any leaks found.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install domestic water piping systems complete with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the domestic water piping systems Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 22 05 27, Pipe Sleeves for Plumbing.
 - 3. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
 - 4. Section 22 05 93, Disinfection of Plumbing Systems.
 - 5. Section 22 07 19, Plumbing Piping Insulation.
 - 6. Section 22 10 53, Installation of Plumbing Piping.
 - 7. Section 22 10 63, Testing of Plumbing Piping Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. ANSI A13.1, Scheme for Identification of Piping Systems.
 - 2. ANSI A21.1, Practice Manual, Computation Strength, Thickness.
 - 3. ANSI A21.4, Cement-Mortar Lining/Cast and Ductile Iron Pipe and Fittings (AWWA C105).
 - 4. ANSI A21.10, Cast-Iron and Ductile Iron Fittings, 2-inches through 48-inches, for Water (AWWA C110).
 - 5. ANSI A21.11, Rubber Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings (AWWA C111).
 - 6. ANSI A21.51, Ductile-Iron Pipe Centrifugally Cast, in Metal Molds (AWWA C151).
 - 7. ANSI A112.1.2, Air Gaps in Plumbing System.
 - 8. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 150 and 800.
 - 9. ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - 10. ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ASME B16.22).

11. ANSI B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, 150 and 300 lbs (ASME B16.24).
12. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
13. ANSI B16.39, Malleable Iron Threaded Pipe Unions.
14. ANSI B16.42, Ductile Iron Pipe Flanges and Flanged Fittings.
15. ANSI B40.1, Gages - Pressure Indicating Dial - Elastic Element.
16. ANSI H 23.1, Seamless Copper Water Tube, (ASTM B 88).
17. ANSI Z358.1, Emergency Eyewash and Shower Equipment.
18. American Society of Sanitary Engineers (ASSE), ASSE 1001, Performance Requirements for Atmospheric Type Vacuum Breakers.
19. ASSE 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
20. ASSE 1018, Trap Seal Primer Valves – Water Supply Fed.
21. ASSE 1020, Performance Requirements for Pressure Vacuum Breaker Assembly.
22. ASTM A 126, Specification for Gray Iron Casting for Valves, Flanges and Pipe Fittings.
23. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
24. ASTM B 32, Specification for Solder Metal.
25. ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.
26. ASTM B 88, Specification for Seamless Copper Water Tube.
27. ASTM D 1330, Specification for Rubber-Sheet Gaskets.
28. AWWA C511, Reduced-Pressure Principle Backflow Prevention Assembly.
29. FS O-F-506, Flux, Soldering: Paste and Liquid.
30. FS WW-U-516, Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections.
31. Plumbing and Drainage Institute (PDI), PDI WH 201, Water Hammer Arresters.

1.3 QUALITY ASSURANCE

A. Installer's Qualifications:

1. Engage a single installer regularly engaged in domestic water piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
2. Engage a single installer for the entire domestic water piping system with undivided responsibility for performance and other requirements.

B. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

- 1 National Electrical Code, (NEC).
- 2 Local and State Building Codes and Ordinances.

- C. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single domestic water piping systems manufacturer.
 - 2. The domestic water piping systems manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the domestic water piping systems manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. 1/4-inch scale piping layouts, dimensioned to show length of piping runs, pipe sizes, support spacing and expansion provisions.
 - b. Details of installation, including piping supports.
 - c. Submit pipe schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications and engineering data.
 - b. Pipe and fittings.
 - c. Valves.
 - d. Flexible connections.
 - e. Other technical data related to the specified material and equipment as requested by ENGINEER.
 - f. Gasket material.
- B. Informational Submittals: Submit the following:
 - 1. Qualifications Statements:
 - a. Installer's qualifications.
- C. Project Closeout Submittals: Submit the following:
 - 1. Record Documentation:
 - a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work, submit CADD drawings showing the actual in place installation of all piping and equipment installed under this Section at a scale satisfactory to the OWNER. The drawings shall reflect all of the piping Work on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the piping systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 GENERAL REQUIREMENTS

- A. The Contract Documents show the general arrangement and extent of the Work to be completed. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.
- B. The Drawings show an indication of the arrangement of equipment, ducts, valves, etc., and are as nearly correct as can be determined in advance of the actual construction of the Work. Piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions, without additional cost to the OWNER.
- C. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case, adequately provide for expansion and perfect circulation and minimize the amount of space required for the same.
- D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.

- E. The Drawings do not show, all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others", to complete the systems to the true extent of the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. General:
1. Materials and equipment indicated as being in contact with potable water or water that will be treated to become potable shall be certified and currently listed as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61.

2.2 MATERIALS

- A. Copper Water Tube:
1. Manufacturers: Provide products of one of the following:
 - a. Mueller Industries.
 - b. JMF Company.
 - c. Or equal.
 2. Tube:
 - a. References: ANSI H23.1, ASTM B 88.
 - b. Type: K or L.
 - c. Temper: Hard-drawn or soft-annealed.
 3. Fittings:
 - a. Reference: ANSI B16.22.
 - b. Reference: ANSI B16.26.
 - c. Reference: ANSI B16.18.
 4. Joints:
 - a. Sweat:
 - 1) Solder Metal: ASTM B 32, Type 95-5TA.
 - 2) Flux: FS O-F-506, Type 1.
 - b. Flanged:
 - 1) Flanges: ANSI B16.24, 150 lb. class.
 - 2) Gaskets: Red rubber, ASTM D 1330, Grade 1, 1/8-inch thick.
 - 3) Nuts and Bolts: ASTM A 307.
 5. Unions:
 - a. Reference: FS WW-U-516.
 - b. Material: Bronze.
 - c. Rating: 250 lb. W.O.G.
 6. Reference: NSF/ANSI 61-G.

B. Dielectric Couplings:

1. Manufacturers: Provide products of one of the following:
 - a. Watts Regulator Company.
 - b. Mueller Industries.
 - c. Or equal.
2. Type: Union or flange.
3. Ratings:
 - a. Unions: 250 psi, ANSI B16.39.
 - b. Flanges: 175 psi, ANSI B16.42 (Iron), ANSI B16.24 (Bronze).
4. Reference: NSF/ANSI 61-G.

2.3 VALVES

A. Bronze Body Globe Valves:

1. Products and Manufacturers: Provide one of the following:
 - a. Milwaukee Valve Product, Globe UP1502.
 - b. Nibco.
 - c. Or equal.
2. Type: Composition disc, union bonnet.
3. Materials: Brass and bronze.
4. Rating: 150 lb. SWP.
5. End Connections: Solder joint.
6. Reference: NSF/ANSI 61-G.

B. Bronze Body Check Valves:

1. Products and Manufacturers: Provide one of the following:
 - a. Stockham Valves and Fittings, Fig. No. LFB-309Y.
 - b. Nibco, Fig. No. S-413-Y-LF.
 - c. Or equal.
2. Type: Swing, regrinding bronze disc, screw-in cap.
3. Materials: Brass and bronze.
4. Rating: 200 lb. CWP.
5. End Connections: Solder joint.
6. Reference: NSF/ANSI 61-G.

C. Bronze Body Ball Valves:

1. Products and Manufacturers: Provide one of the following:
 - a. Nibco, Fig. T-685- 80-LF.
 - b. Milwaukee Valve Product. UPBA400.
 - c. Or equal.
2. Type: Non-blowout stem, adjustable packing gland, quarter turn, full port ball valve.
3. Materials:
 - a. Body: Cast bronze.
 - b. Ball: Chrome plated brass.
 - c. Packing and Seats: Teflon.
4. Rating: 150 lb. SWP.

5. End Connections: Screwed. Provide screwed to sweat adapters, where required.
6. Reference: NSF/ANSI 61-G.
7. Materials:
 - a. Body: Cast bronze.
 - b. Ball: Chrome plated brass.
 - c. Packing and Seats: Teflon.
8. Rating: 150 lb. SWP.
9. End Connections: Screwed. Provide screwed to sweat adapters, where required.

D. Bronze Body Gate Valves:

1. Products and Manufacturers: Provide one of the following:
 - a. Nibco, figure S-136.
 - b. Or equal.
2. Type: Class 150, non-rising stem, solid wedge, union bonnet.
3. Materials: ASTM B 62 Bronze.
4. Rating: 150 psi SWP.
5. End Connections: Solder joint.
6. Reference: MSS SP-80.

E. Strainers:

1. Manufacturers: Provide products of one of the following:
 - a. Mueller Steam Specialty Company.
 - b. Armstrong Steam Specialty Company.
 - c. Or equal.
2. Type: Self-cleaning wye body with blow-off cock.
3. Construction:
 - a. Basket: Perforated stainless steel basket.
 - b. Perforations: 0.045-inches diameter, minimum.
 - c. Free Area: Four times, cross sectional area of connecting pipe, minimum.
4. Strainers 2-1/2-inch and smaller:
 - a. Materials:
 - 1) Body: Cast bronze, ASTM B 62.
 - b. Pressure Rating: 250 psi steam at 425°F temperature.
 - c. End Connections: Solder ends or screwed ends with adapters for screw to sweat ends.
 - d. Blow-off Connection: Unplugged, NPT blow-off connection.
5. Strainers 3-Inches and Larger:
 - a. Construction:
 - 1) Body: Cast-iron, ASTM A 126.
 - b. Pressure Rating: 125 psi steam.
 - c. End Connections: Flanged ANSI B16.1 drilling.
 - d. Blow-off Connections: Tapped, NPT, unplugged.
6. Provide short nipple and blow-off valve for each strainer.

F. Domestic Hot Water Tempering Valve:

1. Manufacturers: Provide products of one of the following:
 - a. Holby Valve Company, Incorporated.
 - b. Heat-Timer Corporation.
 - c. Or equal.
 2. Type: Thermostatically operated water-blending device.
 3. Materials:
 - a. Body: Brass.
 - b. Vanes: Brass.
 4. Thermostatic element to be located in main body of valve.
 5. Water blending chamber to be 23-inches long.
 6. Low outlet temperature type valve shall be adjustable from 60 to 110°F.
 7. Test Pressure: 300 psi.
- G. Tepid Water Mixing Valve:
1. Manufacturers: Provide products of one of the following:
 - a. Guardian, Model No. G3602LF.
 - b. Leonard Water Temperature Controls, Model No. TA-300-LF-STSTL-EXP.
 - c. Or equal.
 2. Type: Thermostatically operated water-blending device.
 3. Materials:
 - a. Body: Brass.
 - b. Vanes: Brass.
 - c. Cabinet: Surface mount, stainless steel.
 4. Thermostatic element to be located in main body of valve.
 5. Outlet dial thermometer.
 6. Locking temperature regulator set at 85°F.
 7. Internal cold water bypass and temperature override protection.
 8. Inlet/Outlet Connections: 1/2-in. NPT.
 8. Minimum Flow: 2 gpm.
 9. Maximum Supply Pressure: 125 psi.
 10. Maximum Supply Temperature: 180°F.
 11. References:
 - a. ANSI Z358-1
 - b. NSF/ANSI 61
 - c. ASSE 1071

2.4 EQUIPMENT

- A. Hose Bibbs (HB):
1. Products and Manufacturers: Provide one of the following:
 - a. Woodford Manufacturing Company, Model 24C.
 - b. Nibco, Incorporated, Fig. No. 74VB.
 - c. Or equal.
 2. Valve:
 - a. Type: Indoor/non-freeze area boiler drain globe valve, chrome plated.
 - b. Materials: Bronze body, screwed bonnet, renewable composition disc.
 - c. End Connections: Hose thread outlet, male pipe thread or sweat inlet.

- d. Rating: 125 lbs. WOG.
- 3. Vacuum Breaker:
 - a. Type: Non-removable, atmospheric.
 - b. Materials: Brass body, stainless steel trim, silicone rubber diaphragm and disc.
 - c. End Connections: Hose thread inlet and outlet.
- B. Wall Hydrants (WH):
 - 1. Encased Hose Connection, Non-Freeze Type:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. No. 5509-QT.
 - 2) Zurn Industries, Fig. No. Z-1300.
 - 3) Or equal.
 - b. Type: Anti-siphon, automatic draining freeze-proof encased wall hydrant for flush mount installation.
 - c. Materials:
 - 1) Casing & Cover: Stainless Steel.
 - 2) Vacuum Breaker: Integral.
 - 3) Threads: Standard 3/4-inch hose thread outlet.
 - 4) Wall Clamp: Adjustable with set screw.
 - 5) Key: Removable tee handle type.
 - d. Connections: 3/4-inch sweat end inlet and 3/4-inch hose thread outlet, universal type.
 - e. Wall thickness: 14-in (Coordinate with Architectural).
- C. Water Hammer Arresters:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Hydrotrol by Jay R. Smith Manufacturing Company.
 - b. Shoktrol by Zurn Industries.
 - c. Or equal.
 - 2. Materials:
 - a. Casing: Stainless steel.
 - b. Bellows: Stainless steel.
 - c. Bellows Contents: Nitrogen gas.
 - 3. Connection: Male NPT thread.
 - 4. Maximum Working Pressure: 250 psig.
 - 5. Sizing and Certification: PDI WH 201.
- D. Pipe Labels:
 - 1. Type: Self-adhering, temperature resistant, waterproof, corrosion resistant.
 - 2. Marker size, marker color, legend size, and legend color shall conform to ANSI A13.1.
- E. Flexible Connections:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Flexonics, Incorporated.
 - b. Anaconda Metal Hose Division, Anamet, Incorporated.
 - c. Or equal.

2. Type: Flexible connections for piping 2-1/2-inches and smaller.
 3. Construction:
 - a. Hose: Bronze.
 - b. Braid: Bronze.
 4. Pressure Ratings: 190 psig working pressure at 250°F temperature.
 5. End Connections: Solder end welded to hose and braid ends.
- F. Automatic Air Vents:
1. Manufacturers: Provide products of one of the following:
 - a. Bell and Gossett.
 - b. Armstrong Pump Company.
 - c. Or equal.
 2. Type: Automatic vent air eliminator with built-in air chamber.
 3. Construction:
 - a. Body: Bronze.
 - b. Finish: Chrome plated exterior.
 - c. Overflow Connector: Provide connection for 1/4-inch OD copper tubing.
 4. Ratings: 75 psig working pressure.
- G. Thermometers:
1. Manufacturers: Provide products of one of the following:
 - a. Weksler Instrument Company.
 - b. H.O. Trerice Company.
 - c. Or equal.
 2. Range: 30°F to 240°F temperature range in maximum of 2°F increments.
 3. Type: Adjustable Angle Column Type Thermometer.
 - a. Construction:
 - 1) Scales and Lens: Nine-inch high satin finish aluminum scales, black numerals, front red reading mercury tubes.
 - 2) Wells: Insertion well with brass separable sockets.
 - 3) Neck: 2-1/2-inch extension neck.
 - 4) Case: Cast aluminum with bronze finish.
 - 5) Window: Glass or clear acrylic plastic.
- H. Pressure Gages:
1. Manufacturers: Provide products of one of the following:
 - a. Weksler Instrument Company.
 - b. H.O. Trerice Company.
 - c. Or equal.
 2. Reference ANSI B40.1 for Grade AA gages.
 3. Type: Direct mounted, dial type pressure gage.
 4. Construction:
 - a. Case: Six-inch diameter cast aluminum, flangeless with black finish and bottom 1/4-inch N.P.T.
 - b. Ring: Chrome plated close type.
 - c. Dial: White face, black numbers and graduations.
 - d. Window: Glass or clear acrylic plastic.

- e. Pointer: Micrometer type, black finish, red tip.
 - f. Movement: Stainless steel, rotary type, delrin sector and bushings.
 - g. Bourdon Tube: Seamless phosphor bronze, Grade A over pressured and stress relieved.
 - h. Socket and Tip: Forged brass, alloy steel and Type 316 stainless steel.
 - 5. Accuracy: One percent minimum.
 - 6. Gage Cocks: Provide brass tee handle isolation cock before each gage.
- I. Backflow Preventers: 1/2-Inch to 2-Inches: RPZ-BFP:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Febco, Model 825Y.
 - b. Watts Regulator Company, Series 909.
 - c. Or equal.
 - 2. Type: Reduced pressure zone device with two independently acting check valves, together with an automatically operated pressure differential relief valve located between the two check valves.
 - 3. Materials:
 - a. Body: Bronze.
 - b. Valve Discs: BUNA-N rubber.
 - c. Diaphragm: Silicone rubber or Buna-N rubber.
 - d. Springs: Stainless steel.
 - e. Screws: Stainless steel.
 - 4. Maximum Working Pressure: 150 psi.
 - 5. End Connections: Screwed.
 - 6. Accessories:
 - a. Air gap drain funnel with threaded outlet and vent elbow furnished by manufacturer.
 - b. Strainer with ball-valve blow-off on inlet.
 - c. Full port quarter turn ball valves on inlet and outlet.
 - d. Reduced pressure principle backflow preventer test kit for each unit furnished, provided in molded plastic carrying case with foam inserts.
 - 7. References: ASSE 1013, AWWA C511 and authority having jurisdiction at the Site.
- J. Vacuum Breakers:
- 1. Pressure Type: PVB:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Watts Regulator Company, No. 800.
 - 2) Conbraco Industries, Incorporated, Series 40-500.
 - 3) Febco, Model 765.
 - 4) Or equal.
 - b. Type: An assembly containing an independently operating internally loaded check valve and an independently operating loaded air inlet valve located on the discharge side of the check valve. The assembly shall also be equipped with test cocks and shut off valves on the inlet and outlet of the assembly.
 - c. Materials:
 - 1) Hood: Stainless steel.

- 2) Bonnet: Bronze.
 - 3) Vent Disc: Silicone rubber.
 - 4) Disc Holder Float: Polyethylene.
 - 5) Check Valve Disc: Silicone rubber.
 - 6) Check Valve Seat: Bronze.
 - 7) Body: Bronze.
 - d. Accessories:
 - 1) Ball valves on inlet and outlet on the assembly.
 - 2) Ball valve test cocks on the assembly.
 - e. Reference: ASSE 1020.
 - f. Working Pressure: 150 psi.
 - g. Installation: Vertical, minimum 12-inches above fixture vacuum breaker serves.
2. Atmospheric Type: AVB:
- a. Products and Manufacturers: Provide one of the following:
 - 1) Watts Regulator Company, No. 288A.
 - 2) Conbraco Industries, Incorporated, Series 38.
 - 3) Febco, Model 710/715, as required.
 - 4) Or equal.
 - b. Type: An assembly containing an air inlet valve, a check seat and an air inlet port to prevent reverse flow of water and allow air into the water line to break a siphon.
 - c. Materials:
 - 1) Hood: Bronze.
 - 2) Body: Bronze.
 - 3) Vent Disc: Silicone.
 - 4) Disc Holder Float: Polyethylene.
 - 5) Body: Bronze.
 - d. Reference: ASSE 1001.
 - e. Working Pressure: 210°F at 125°F.
 - f. Installation: Vertical, minimum 6-inches above fixture vacuum breaker serves.

K. Hose Rack (HR):

- 1. Products and Manufacturers: Provide one of the following:
 - a. Armstrong, Model 041R.
 - b. R&S Supply Company, Model 11S.
 - c. Or equal.
- 2. Type: Heavy duty wall mounted hose rack.
- 3. Materials: 3/8" 14-gauge type 304 stainless steel.
- 4. Mounting Plate: 4 holes, 16" on center.
- 5. Capacity: 50' of 1" dia. hose.

L. Hose:

- 1. Products and Manufacturers: Provide one of the following:
 - a. Croker-Standard, Fig. No. 7037 with brass coupling for non-collapsible hose.
 - b. Potter Roemer, Fig. No. 2852 hose with Fig. No. 2862 coupling.

- c. Or equal.
 - 2. Type: Double braided synthetic hose for use with continuous flow reels to permit flow while hose is coiled on reel. Couplings shall connect to hose nozzle threads and male hose outlet threads on hose reel.
 - 3. Threads: 1-inch N.S.T.
 - 4. Hose Size: 1-inch.
 - 5. Length: 50 feet, one continuous length with no intermediate couplings.
- M. Quick Coupler Connections:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Dover Corporation; OPW "Kamlok" 633 series.
 - b. Or equal.
 - 2. Type: Cam arms lock into adaptor groove.
 - 3. Materials: Adaptor and Coupler:
 - a. Body: Stainless steel.
 - b. Cam Arms: Stainless steel.
 - c. Gaskets: Buna N.
 - 4. End Connections: Socket weld quick connect adaptor for connection to copper tubing; hose shank quick connect coupler.
 - 5. Reference: MIL-C-27487.
- N. Hose Nozzles:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Croker-Standard, Fig. No. 3477.
 - b. Potter Roemer, Incorporated, Fig. No. 2959.
 - c. Or equal.
 - 2. Materials:
 - a. Body: Brass.
 - b. Stem: Brass.
 - c. Bumper: Rubber.
 - 3. Threads: One-inch N.S.T.
 - 4. Nozzle: Adjustable fog nozzle, capable of complete shut-off, solid straight stream, or any degree of solid conical fog.
- O. Pressure Reducing Valves:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Watts Model LFX65B.
 - b. Apollo Valves, Model 36E.
 - c. Or equal.
 - 2. Design Conditions:
 - a. Inlet Pressure: 100 psig.
 - b. Outlet Pressure: 60 psig.
 - c. Average Flow Rate: 20 gpm.
 - 3. Type: Direct acting, cartridge style.
 - 4. Adjustment: Pressure setting adjustment to be made with single screw.
 - 5. Materials:
 - a. Main Body and Valve Cover: Bronze.
 - b. Main Valve Trim: Brass and bronze.

6. Adjustment Range: 20 to 80 psig outlet.
7. Pressure Rating: 150 class - 275 psi, maximum.
8. End Connections: Threaded NPT.

P. Trap Primer Valve:

1. Manufacturers: Provide products of one of the following:
 - a. Precision Plumbing Products, PT-4.
 - b. Siouz Chief
 - c. Or equal.
2. Type: Electronic trap priming, surface-mounted assembly.
3. Construction:
 - a. Metal cabinet, NEMA 4.
 - b. Pipe and Valve Assembly: Copper and Brass.
 - c. Built-in timer.
 - d. Inlet: 3/4-inch.
 - e. Outlet: (8)-1/2-inch copper outlets.
 - f. Integral backflow preventer.
 - g. Temperature/Pressure: 32°F-125°F/20 PSI-150 PSI.
 - h. Electrical: 120-volt, single phase, 60 hertz.
4. References:
 - a. NSF/ANSI 61.
 - b. ASSE 1018.

Q. Emergency Eyewash Equipment:

1. Emergency Eye/face Wash Station (EW):
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Guardian, Model G1781.
 - 2) Speakman Company, SE-582.
 - 3) Or equal.
 - b. Type: Wall mounted, stainless steel eye/face wash with dual aerated spray heads.
 - c. Materials:
 - 1) Eye/Face-Wash: Stainless steel bowl with twin Buna-N covered ABS heads and stainless steel ball valve, stay open type.
 - 2) Push handle activator: Stainless Steel
 - d. Supply: 1/2-inch NPT
 - e. Accessories: P-trap
 - e. Certified to ANSI/ISEA Z358.1
2. Safety Valve Lockout with Padlock:
 - a. Heavy-duty plastic, dielectric and chemical resistant valve lock.
 - b. Padlock with unique serial number, hardened steel shackle, and two brass keys with matching serial numbers for each padlock.
 - c. Manufacturers: Provide products of one of the following:
 - 1) Akron, Safety Products, Inc.
 - 2) Brady USA, Inc.
 - 3) Or equal.
3. Anti-Scald Valves:

- a. Anti-scald valve provides scald protection and bleeds valve whenever internal temperature rises above 95°F and closes when line temperature drops to 95°F.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Haws Drinking Faucet Company, Model SP157A scald-protection valve.
 - 2) Speakman Company.
 - 3) Or equal.
- R. Tepid Water Temperature Maintenance Heat Tracing:
 1. Manufacturers: Provide products of one of the following:
 - a. Thermon Manufacturing Company.
 - b. Tyco Thermal Controls.
 - c. Chromalox.
 2. General: Furnish, install and test a complete UL listed system of heat trace cable(s) and components approved and designed specifically for maintaining a minimum tepid water temperature of 85°F for emergency eyewash and shower equipment. All piping systems as specified below shall be electrically traced with self-limiting heaters. Adjustable control thermostats, to maintain a constant water temperature for the tepid water heat tracing system shall be provided as recommended by the manufacturer.
 - a. Tepid Water Piping: All exposed potable water piping serving emergency showers and eyewash stations shall be maintained to a temperature of 85°F.

Manufacturer shall assist in selecting the correct tracer and developing a recommended Bill of Materials. All components of the systems shall be a product of one manufacture. All connections and equipment shall be moisture-proof.
 3. The heater cable assembly shall consist of two No. 14 AWG parallel nickel-plated copper bus wires imbedded in a self-regulating core and covered in a cross-linked polyolefin insulating jacket. The heater assembly shall be covered with tinned copper metallic braid and an outer jacket of cross-linked polyolefin insulation, nominally of 40-mil thickness, and color-coded for easy identification.
 - a. Provide electric heat trace cables equal to the following Thermon products:
 - 1) Tepid Water System: HSX 2105 (Blue) fitted with adjustable control Thermostat equal to E4X-25325.
 4. The cable shall be rated for 208 Volt operation.
 5. Pipe and heat trace shall be insulated with 1-1/2-inch thick fiberglass insulation as described in Section 22 07 19, Insulation of Plumbing Piping.
 6. Provide a NEMA 4X rated splicing power-to-tracing connectors or kits and required electrical equipment enclosures for all the buildings and areas. The heat trace cable shall be furnished complete with all necessary power connectors, thermostats, end terminations, splice kits, straps, ground fault circuit breakers, junction boxes, etc., as required. Coordinate required power supplies and connection with Division 16, Electrical.

7. Perform required cable test in accordance with manufacturer's instructions and recommendations.

2.4 PAINTING

- A. Piping and accessories shall be painted in accordance with Section 09 91 00, Painting.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General:
 1. Install all items as shown, specified, and as recommended by the manufacturers.
 2. Request instructions from ENGINEER, in writing, when there is a conflict between the manufacturer's recommendations and the Contract Documents.
 3. Present conflicts between piping systems and/or equipment and/or structures to ENGINEER, in writing, who will determine corrective measures to be taken.
 4. Do not modify structures to facilitate installation of piping, unless specifically approved by ENGINEER.
 5. Installation shall conform to requirements of all local and state codes.
 6. Properly plug or cap the open ends of all piping at the end of each day's Work or other stopping point through construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.2 FIELD QUALITY CONTROL

- A. Field Tests:
 1. Fill all systems and fully test all equipment, valves, dampers, etc. in operation.
 2. Check for excessive vibration while all systems are operating.
 3. Installed systems and components will not be released to OWNER, unless all systems have been tested and approved by the ENGINEER.
- B. Inspection:
 1. Examine areas to receive piping, valves and accessories for:
 - a. Defects that adversely affect execution and quality of the Work.
 - b. Deviations beyond allowable tolerances for piping, valves and accessories.
 - c. Start the Work only when conditions are satisfactory.
 2. The ENGINEER reserves the right to reject or authorize replacement of piping and accessories found to defective.

3.3 ADJUSTING AND CLEANING

A. Adjusting:

1. Adjust all controls for proper settings.
2. While system is operable balance all equipment, valves, dampers, etc. to achieve design conditions.

B. Cleaning:

1. Thoroughly clean all piping, fittings, valves, and accessories prior to installation.
2. Remove all dirt, rust, dust, etc. from piping in preparation for painting.
3. Remove and dispose of all debris and waste from the Site resulting from installation.

3.4 MATERIAL SCHEDULES

A. Piping:

1. Use types of pipe and fittings as specified below, unless otherwise specified or shown.
2. All potable water supply, hot, cold, tempered water circulation piping 2-1/2-inches and smaller, run within the interior of a building, shall be hard-drawn copper Type "L" with solder joints and connections.
3. All potable water piping 2-1/2-inches and smaller run underground shall be soft-annealed copper Type "K" copper tubing.
4. All underground water piping 3-inches and larger shall be cement-lined ductile iron pipe with mechanical joints.
5. All water piping 3-inches and larger run within the interior of a building, shall be cement-lined ductile iron pipe with flanged or grooved joints.
6. All exposed water piping and valves to plumbing fixtures shall be chrome-plated brass.
7. All valves for copper or brass piping shall be bronze bodied, unless otherwise specified.
8. All valves for ductile iron piping shall be iron bodied, unless otherwise specified.
9. Use "wrought copper" fittings for copper tubing.
10. Use "butt welded" fittings for welded steel pipe connections.

++ END OF SECTION ++

++NO TEXT ON THIS PAGE++

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install sanitary waste and vent piping systems complete with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the sanitary waste and vent piping systems Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 22 05 27, Pipe Sleeves for Plumbing.
 - 3. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
 - 4. Section 22 10 53, Installation of Plumbing Piping.
 - 5. Section 22 10 63, Testing of Plumbing Piping Systems.
 - 6. Section 31 20 00, Earth Moving.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - a. ANSI B16.12, Cast-Iron Threaded Drainage Fittings.
 - b. ANSI B125.2, Black/Hot-Dipped Zinc Coated Welded/Seamless Pipe.
 - 2. American Society of Sanitary Engineering, (ASSE).
 - 3. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 74, Specification for Cast-Iron Soil Pipe and Fittings.
 - b. ASTM A 518/A 518M, Specification for Corrosion-Resistant High-Silicon Iron Castings.
 - c. ASTM A 861, Specification for High-Silicon Iron Pipe and Fittings.
 - d. ASTM A 888, Specification for Hubless Cast-Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
 - e. ASTM C 564, Specification for Rubber Gaskets for Cast-Iron Soil Pipe and Fittings.
 - f. ASTM D 1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.

- g. ASTM D 2665, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
- 4. Cast-Iron Soil Pipe Institute, (CISPI).
 - a. CISPI 310 Specification for Couplings for Use in Connection with Hubless Cast-Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
 - b. CISPI HSN, Specification for Neoprene Rubber Gaskets for Hub and Spigot Cast-Iron Soil Pipe and Fittings.
- 5. Federal Specifications, (FS).
 - a. FS QQ-C-40, Calking Lead Wool and Lead Pig.

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications:
 - 1. Engage a single installer regularly engaged in sanitary piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
 - 2. Engage a single installer for the entire sanitary waste and vent piping system with undivided responsibility for performance and other requirements.
- B. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. American National Standards Institute, (ANSI).
 - 2. American Society of Mechanical Engineers, (ASME).
 - 3. National Sanitary Foundation, (NSF).
 - 4. Local and State Building Codes and Ordinances.
 - 5. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.
- C. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single sanitary waste and vent piping systems manufacturer.
 - 2. The waste and vent piping systems manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the sanitary waste and vent piping systems manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. 1/4-inch scale piping layouts, dimensioned to show length of piping runs, pipe sizes, support spacing and expansion provisions.
 - b. Details of installation, including piping supports.

- c. Submit pipe schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications and engineering data.
 - b. Pipe and fittings.
 - c. Drains.
 - d. Cleanouts.
 - e. Flexible connections.
 - f. Other technical data related to the specified material and equipment as requested by ENGINEER.
 - g. Gasket material.
- B. Informational Submittals: Submit the following:
 - 1. Qualifications Statements:
 - a. Installer's Qualifications
- C. Record Documentation: Submit the following:
 - 1. Record Drawings:
 - a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work, submit CADD drawings showing the actual in place installation of all piping and equipment installed under this Section at a scale satisfactory to the OWNER. The drawings shall reflect all of the piping Work on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the piping systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
- B. Storage of Materials:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 GENERAL REQUIREMENTS

- A. The Contract Documents show the general arrangement and extent of the Work to be completed. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.
- B. The Drawings show an indication of the arrangement of equipment, piping, valves, etc., and are as nearly correct as can be determined in advance of the actual construction of the Work. Piping, equipment, etc., found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.
- C. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case and adequately provide for expansion and perfect circulation and minimize the amount of space required for the same.
- D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.
- E. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others", to complete the systems to the true extent of the Contract Documents.

PART 2 - PRODUCTS

2.1 PIPING

A. Cast-Iron Pipe:

1. Products and Manufacturers: Provide one of the following:
 - a. Charlotte Pipe & Foundry Company

- b. Tyler Pipe Company.
 - c. Or equal.
 - 2. Hub & Spigot Cast-Iron Soil Pipe and Fittings:
 - a. Pipe and Fittings: ASTM A 74.
 - b. Weight: Service Weight.
 - c. Joints:
 - 1) Compression:
 - a) Gasket: Neoprene Rubber, ASTM C 564, CISPI HSN.
 - b) Lubricant: As recommended by pipe manufacturer.
 - 2) Calked:
 - a) Lead: FS QQ-C-40, Type I, Grade AA.
 - b) Jute Packing: FS HH-P-117, Type I.
 - 3. Hubless Cast-Iron Soil Pipe and fittings:
 - a. Pipe and Fittings: ASTM A 888 & CISPI 301
 - b. Joints: CISPI 310 & ASTM C 1277
 - 1) Heavy duty hubless couplings: ASTM C1540
 - 2) Gaskets: ASTM C 564
- B. Steel Pipe and Fittings:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Mueller Industries
 - b. Wheatland Tube Co.
 - c. Or equal.
 - 2. Pipe:
 - a. ANSI B125.2.
 - b. ASME/ANSI B1.20.1 (Threads)
 - 3. Weight: Schedule 40.
 - 4. Finish: Galvanized.
 - 5. Fittings: ANSI B16.12 recessed drainage pattern galvanized cast-iron, threaded so as to allow 1/8-inch or 1/4-inch per foot grade, as required.
- C. Polyvinyl Chloride (PVC) Pipe and Fittings:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Charlotte Pipe & Foundry Company
 - b. Tyler Pipe Company.
 - c. Or equal.
 - 2. Type: Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D 1784 and conform to NSF 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665.
 - 3. Weight: Schedule 40, Solid Wall.
 - 4. Fittings: Injection molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866.
 - 5. Joints: Solvent weld with manufactures recommended solvents and shall conform to ASTM D 2564. Primer shall conform to ASTM F 656. The system shall be for non-pressure drainage applications where the temperatures not exceeding 140°F.

2.2 DRAINS AND CLEANOUTS

A. Drains and Cleanouts:

1. Floor Drain, Light Duty, Finished Areas (FD-1).
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. 2010-BP.
 - 2) Zurn Industries, Fig. Z-415 with S-strainer.
 - 3) Or equal.
 - b. Materials:
 - 1) Body: Enameled cast-iron.
 - 2) Collar: Cast-iron, reversible, threaded for strainer heads, enamel coated.
 - 3) Strainer Head: Square 8-inch by 8-inch nickel bronze grate with bronze body, heel proof grate, and vandal proof screws.
 - c. Outlet Connection: Bottom outlet, calk or no-hub, as required.
 - d. Trap primer connection on body with thread to solder adapter, as required.
 - e. Provide 4" Dia. funnel attachment where indicated on Plans.
2. Floor Drain, Heavy Duty (FD-2).
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. 2340.
 - 2) Zurn Industries, Fig. Z-521.
 - 3) Or equal.
 - b. Materials:
 - 1) Body: Enameled cast-iron.
 - 2) Collar: Enameled cast-iron.
 - 3) Top: Enameled cast-iron adjustable.
 - 4) Grate: Ductile iron, 11-1/2-inch diameter.
 - c. Accessories: Sediment bucket.
 - d. Rating: Heavy-duty.
 - e. Outlet Connection: Bottom outlet, calk or no-hub, as required.
 - f. Provide 4" Dia. funnel attachment where indicated on Plans.
 - g. Trap primer connection on body with thread to solder adapter, as required.
3. Floor Drain, Heavy Duty Shallow Body (FD-3).
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. 2140/2145.
 - 2) Zurn Industries, Fig. Z-509/Z-509-90.
 - 3) Or equal.
 - b. Materials:
 - 1) Body: Enameled cast-iron.
 - 2) Collar: Enameled cast-iron.
 - 3) Top: Enameled cast-iron adjustable.
 - 4) Grate: Ductile iron, 11-1/2-inch diameter.
 - c. Rating: Heavy-duty.
 - d. Outlet Connection: Bottom outlet, calk or no-hub, as required. Side outlet style shall be used, where required by existing conditions.
 - e. Accessories: Sediment bucket.

4. Flap Valve Drain.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Norham Multitube, Model NB.
 - 2) SVR Plastics, LTD.
 - 3) Or equal.
 - b. Type: Vertical wall mount, inclined flap valve.
 - c. Materials:
 - 1) Body: Glass reinforced plastic.
 - 2) Gasket: EPDM rubber.
 - 3) Hardware: Stainless steel mechanical anchors.
 - d. Incline: Minimum 15 degrees.
 - e. Backpressure: 1 bar (14.5 psi).
 - f. Provide at all drains discharging to outside.
- B. Cleanouts:
1. Cleanout Deck Plates, Finished Areas (FCO-1):
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. 4040.
 - 2) Zurn Industries, Fig. No. Z-1400-3.
 - 3) Or equal.
 - b. Materials: Cast-iron body and adjustable nickel bronze top.
 - c. Outlet Connection: Standard spigot.
 - d. Accessories:
 - 1) Square nickel bronze top.
 - 2) Cast bronze taper thread plug.
 2. Cleanout Deck Plate, Traffic Areas (FCO-2):
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. No. 4250.
 - 2) Zurn Industries, Fig. No. Z-1474.
 - 3) Or equal.
 - b. Materials: Cast-iron body, flanged housing, cast-iron cover with fitting device.
 - c. Outlet Connection: Calk outlet.
 3. Wall Cleanout Plate (WCO):
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. 4402.
 - 2) Zurn Industries, Fig. No. Z-1441.
 - 3) Or equal.
 - b. Materials: Cast bronze taper thread plug.
 - c. Accessories:
 - 1) Stainless steel round shallow wall plate.
 - 2) Cast-iron calked ferrule.

2.3 PAINTING

- A. All piping and accessories shall be painted in accordance with the requirements of Section 09 91 00, Painting.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Install all items as shown, specified, and as recommended by the manufacturer.
2. Request instructions from ENGINEER, in writing, when there is a conflict between the manufacturer's recommendations and the Contract Documents.
3. Present conflicts to ENGINEER, in writing, who will determine corrective measures to be taken.
4. Do not modify structures to facilitate installation of piping, unless specifically approved by ENGINEER.
5. Installation shall conform to requirements of all local and state codes.
6. Installation of piping shall be in accordance with Section 22 10 53, Installation of Plumbing Piping.
7. Installation of hangers and supports shall be in accordance with Section 22 05 29, Hangers and Supports for Plumbing and Piping Equipment.
8. Protection: Properly plug or cap the open ends of all piping at the end of each day's Work or other stopping point through construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.2 FIELD QUALITY CONTROL

A. Field Tests:

1. Tests: Water or smoke test piping in accordance with Section 22 10 63, Testing of Plumbing Piping Systems.
2. Fill all systems and fully test all equipment, valves, etc. in operation.
3. Check for excessive vibration while all systems are operating.
4. Installed systems and components will not be released to OWNER, unless all systems have been tested and approved by the ENGINEER.

B. Inspection:

1. Examine areas to receive piping, valves and accessories for:
 - a. Defects that adversely affect execution and quality of the Work.
 - b. Deviations beyond allowable tolerances for piping, valves and accessories.
 - c. Start the Work only when conditions are satisfactory.
2. The ENGINEER reserves the right to reject or authorize replacement of piping and accessories found to defective, blistered, cracked or deviated from allowable tolerances as described above.

3.3 ADJUSTING AND CLEANING

A. Adjusting:

1. While system is operable, balance all equipment, valves, etc. to achieve design conditions.
- B. Cleaning:
1. Thoroughly clean all piping, fittings, valves, and accessories prior to installation.
 2. Remove all dirt, rust, dust, etc. from piping in preparation for painting.
 3. Remove and dispose of all debris and waste from the Site resulting from installation.

3.4 MATERIAL SCHEDULES

- A. Piping:
1. Use types of pipe and fittings as specified below, unless otherwise specified or shown.
 2. All exposed gravity sanitary waste and vent piping run within the interior of a building shall be no-hub cast-iron.
 3. All gravity sanitary waste and vent piping located in concrete slabs or underground to exterior limits as shown shall be service weight hub & spigot cast-iron soil pipe.
 4. Sump pump discharge piping and fittings shall be schedule 40 PVC.
 4. Use polyvinyl chloride piping and fittings for drain waste and vent piping only as approved by Owner and as allowed by local plumbing code.

++ END OF SECTION ++

++NO TEXT ON THIS PAGE++

SECTION 22 18 00

NATURAL GAS PIPING SYSTEM - PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install natural gas piping system complete with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the gas piping systems Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 22 05 27, Pipe Sleeves for Plumbing.
 - 3. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
 - 4. Section 22 10 53, Installation of Plumbing Piping.
 - 5. Section 22 10 63, Testing of Plumbing Piping Systems.
 - 6. Section 31 20 00, Earth Moving.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - a. ANSI A13.1, Scheme for Identification of Piping Systems.
 - b. ANSI B125.2, Black/Hot-Dipped Zinc Coated Welded/Seamless Pipe.
 - 2. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 53/A 53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. ASTM B 88, Specification for Seamless Copper Tube.
 - 3. National Fuel Gas Code, NFPA 54.
 - 4. International Fuel Gas Code, (IFGC).

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications:
 - 1. Engage a single installer regularly engaged in gas piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.

2. Engage a single installer for the gas piping system with undivided responsibility for performance and other requirements.
 3. All welding shall be performed in accordance with ANSI B31.1, ANSI B31.8 and AWWA C206 except as modified or supplemented herein. All welders shall be AWS certified in accordance with AWWA C206, and ANSI B31.1 requirements. Welders shall have their current certificate available for the ENGINEER's inspection.
 - a. Each welder shall be required to identify his weld with his specific code marking signifying his name and assigned number.
 - b. For piping systems with service temperatures in excess of 120 degrees Fahrenheit, each welder shall be examined at the job site by the CONTRACTOR in the presence of the ENGINEER to determine the ability of the welder to meet the qualifications required. Welders shall be tested for all positions including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified. It shall be the CONTRACTOR's responsibility to assign only the site tested welders to this piping.
 - c. When a welder fails to meet the prescribed welding qualifications and/or fails an on-site examination, or is responsible for a defective weld, that welder shall be retested on the job site. If he fails a second on-site examination he shall be disqualified for work on the project.
 4. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds under light for surface cracking, porosity, and slag inclusions, excessive roughness, unfilled craters, gas pockets, undercuts, overlaps, size, and insufficient throat and concavity.
- B. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. American National Standards Institute, (ANSI).
 2. American Society of Mechanical Engineers, (ASME).
 3. National Fire Protection Association, (NFPA).
 4. Underwriters' Laboratories, Incorporated, (UL).
 5. Local and State Building Codes and Ordinances.
 6. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.
- C. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single gas piping system manufacturer.
 2. The gas piping systems manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the gas piping systems manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. 1/4-inch scale piping layouts, dimensioned to show length of piping runs, pipe sizes, support spacing and expansion provisions.
 - b. Details of installation, including piping supports.
 - c. Submit pipe schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications and engineering data.
 - b. Pipe and fittings.
 - c. Valves.
 - d. Flexible connections.
 - e. Other technical data related to the specified material and equipment as requested by ENGINEER.
 - f. Gasket material.
- B. Informational Submittals: Submit the following:
 - 1. Qualifications Statements:
 - a. Installer's Qualifications
- C. Record Documentation: Submit the following:
 - 1. Record Drawings:
 - a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of piping Work, submit CADD drawings showing the actual in place installation of all piping and equipment installed under this Section at a scale satisfactory to the OWNER. The drawings shall reflect all of the piping Work on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the piping systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
- B. Storage of Materials:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 GENERAL REQUIREMENTS

- A. The Contract Documents show the general arrangement and extent of the Work to be completed. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.
- B. The Drawings show an indication of the arrangement of equipment, piping, valves, etc., and are as nearly correct as can be determined in advance of the actual construction of the Work. Piping, equipment, etc., found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.
- C. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case and adequately provide for expansion and perfect circulation and minimize the amount of space required for the same.
- D. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.
- E. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others", to complete the systems to the true extent of the Contract Documents.

PART 2 - PRODUCTS

2.1 PIPING

A. Steel Pipe:

1. Pipe:

- a. Reference: Pipe sizes 2-inches to 24-inches ASTM A53, Type S, Schedule 40, Grade B.
- b. Reference: Pipe sizes less than 2-inches: ASTM A106, Schedule 40.
- c. Weight: Schedule 40.
- d. Finish: Black.
- e. Piping 2-inches and larger shall conform to ASTM A53.
- f. Piping 1 1/2-inches and smaller shall conform to ASTM A106.
- g. End Connections:
 - 1) Schedule 40: Up to 2-1/2-inch size, may be threaded.
 - 2) Schedule 40: 3-inch and larger shall be welded; weld end (API 1104, ASME Section IX Boiler and Pressure Vessel Code. Connections to regulators, valves, meters with flanged ends shall be flanged).

2. Fittings:

a. Threaded:

- 1) Reference: ANSI B16.33, 150 pound.
- 2) Material: Malleable iron.
- 3) Finish: Black.

3. Unions:

- a. Threaded: Malleable iron, FS WW-U-531, Class 1, Type B.

4. Joint Compound:

- a. Material: Resistant to the action of liquefied petroleum gas or natural gas.

5. Insulating couplings, Dresser, a steel body with gaskets and retainer cups.

2.2 VALVES

A. Lubricated Plug Valves:

1. Manufacturer: Provide products of one of the following:

- a. Walworth Company.
- b. Nordstrom Valves, Inc.
- c. Valmatic.
- d. Or equal.

2. Type: Short pattern, wrench operated.

3. Pressure rating: 175 lb wog - 350 lb test.

4. End connections: Threaded (up to 2-1/2-inch); flanged (3-inch and larger).

5. Construction: Cast iron body and plug with steel trim.

6. Sealant: Suitable for gas application.

7. Wrench: To suit valve.

B. Lubricated Stop Cocks (1/2"-2"):

1. Manufacturer: Provide products of one of the following:
 - a. Eclipse Fuel Engineering Company.
 - b. A. Y. McDonald Manufacturing Company.
 - c. Or equal.
2. Type: Flat head.
3. Pressure rating: 125 lb wog.
4. End Connections: Threaded.
5. Construction: Iron body, bronze plug

2.3 EQUIPMENT

- A. Natural Gas Pressure Regulator: In accordance with the requirements of the local utility company.
- B. Natural Gas Meter
 1. Manufacturer: In accordance with requirements of the local utility company.
- C. Dielectric Couplings:
 1. Manufacturer: Provide products of one of the following:
 - a. Epco Sales Incorporated.
 - b. Watts Regulator Company.
 - c. Or equal.
 2. Type: Union.
- D. Vent Pipe Caps:
 1. Manufacturer: Provide products of one of the following:
 - a. UPSCO, Incorporated.
 - b. Richards Manufacturing Company.
 - c. Or equal.
- E. Flexible Connectors:
 1. Manufacturer: Provide products of one of the following:
 - a. Metraflex Company, Model GASCT0250.
 - b. Flexicraft Industries.
 - c. Or equal.
 2. Description: Provide flexible hose connector(s) as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction or seismic movement of the piping system.
 3. Type: Flexible hose connectors, complete with section of corrugated metal house, compatible braid, with inlet and outlet connections as required, capable of compensating for lateral movement and vibration.
 4. Materials:
 - a. Corrugated Hose: 304 Stainless steel.
 - b. Braid: 304 Stainless Steel.
 - c. Fittings: Consistent with pipe material and equipment/pipe connection fittings.
 5. Pressure Rating: 150 PSI at (70°F)

6. Connections: Schedule 40 MPT.
7. References: CSA/AGA certified.

2.4 NAMEPLATES AND MARKINGS

- A. All pipeline materials shall be stamped, marked or identified with the following:
 1. Name of manufacturer.
 2. Pipe size.
 3. Material.
 4. Wall thickness.
 5. Rating.

2.5 PAINTING

- A. All piping and accessories shall be painted in accordance with the requirements of the local utility company and Section 09 91 00, Painting.

2.6 FINISH

- A. Exposed Piping:
 1. A coat of rust inhibitive primer in conformance with Section 09 91 00 shall be applied before painting the exterior of the pipe.
- B. Buried Piping:
 1. The exterior coating for the underground gas piping shall be extruded polyolefin resin meeting the requirement of NACE SP0185-2007 which is made part of these specifications. The polyolefin resin shall be crosshead-extruded on the pipe as a seamless coating over hot-applied Mastic adhesive as manufactured by Royston Labs Inc. or equal.
 2. The coating application thickness shall conform to the manufacturer's specifications with minimum 8 mils of adhesive and 23 mils of polyethylene. All coated pipe shall be 100% electrically inspected for holidays immediately after coating application. The voltage of the holiday detector shall be adjusted to the level specifically recommended for the thickness of the coating but shall not be less than 6,000 volt.
 3. The coated pipe shall be handled, shipped and stored in strict accordance with SP0185-2007 or the pipe coating company's standards. Field coating for pipe joints and holiday repairs shall be made using heat shrinkable sleeves or wraps in accordance with SP0185-2007.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General:
 1. Install all items as shown, specified, and as recommended by the manufacturer.

2. Request instructions from ENGINEER, in writing, when there is a conflict between the manufacturer's recommendations and the Contract Documents.
3. Present conflicts to ENGINEER, in writing, who will determine corrective measures to be taken.
4. Do not modify structures to facilitate installation of piping, unless specifically approved by ENGINEER.
5. Installation shall conform to requirements of all local and state codes.
6. Installation of piping shall be in accordance with Section 22 10 53, Installation of Plumbing Piping and NFPA 54 (ANSI Z223.1).
7. Installation of hangers and supports shall be in accordance with Section 22 05 29, Hangers and Supports for Plumbing and Piping Equipment.
8. Unions shall be provided for all screwed piping at connections to equipment and at convenient locations to permit disassembly of piping.
9. Wherever changes in sizes of piping occur, changes shall be made with reducing fittings. The use of bushings is not permitted unless otherwise shown.
10. All underground piping shall be coated with 2 coats of coal tar enamel.
11. All underground service piping shall be installed with a minimum cover of 2'-6".
12. All joints are to be welded except that "Dresser" type connections shall be used at drip pots and valves. Provide an 8 gauge, copper, bonding wire brazed to pipe on both sides of the "Dresser" fitting.
13. Gas service lines shall pitch away from building, where possible. If they are pitched toward the building they shall be provided with drip leg and plugged outlet or drip pot as required.
14. All gas piping in building shall be straight, free from traps and unnecessary bends and conform to building construction. Piping shall be graded 1" in 40 feet to be provided for drainage of moisture, by 6" drip legs in accessible locations at low points of system. Branch connections to mains shall be from top of main or at a 45° angle.
15. Each gas pressure regulator shall be vented through the roof and terminated 6 feet 0-inches above the roof with an approved gas vent cap.
16. Solenoid vent valve vents furnished on gas-fired equipment with Gas Trains shall be individually vented through the roof and terminated 6-feet 0-inches above the roof with an approved gas vent cap.
17. Make final connections to gas-fired equipment furnished by HVAC Contractor.
18. Protection: Properly plug or cap the open ends of all piping at the end of each day's Work or other stopping point through construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.2 FIELD QUALITY CONTROL

A. Field Tests:

1. Tests: Air test piping in accordance with Section 22 10 63, Testing of Plumbing Piping Systems and local utility gas company.
2. Fill all systems and fully test all equipment, valves, etc. in operation.

3. Check for excessive vibration while all systems are operating.
4. Installed systems and components will not be released to OWNER, unless all systems have been tested and approved by the ENGINEER.

B. Inspection:

1. Examine areas to receive piping, valves and accessories for:
 - a. Defects that adversely affect execution and quality of the Work.
 - b. Deviations beyond allowable tolerances for piping, valves and accessories.
 - c. Start the Work only when conditions are satisfactory.
2. The ENGINEER reserves the right to reject or authorize replacement of piping and accessories found to defective, blistered, cracked or deviated from allowable tolerances as described above.

3.3 ADJUSTING AND CLEANING

A. Adjusting:

1. While system is operable, balance all equipment, valves, etc. to achieve design conditions.

B. Cleaning:

1. Thoroughly clean all piping, fittings, valves, and accessories prior to installation.
2. Remove all dirt, rust, dust, etc. from piping in preparation for painting.
3. Remove and dispose of all debris and waste from the Site resulting from installation.

3.4 MATERIAL SCHEDULES

A. Piping:

1. Use types of pipe and fittings as specified below, unless otherwise specified or shown.
2. All gas piping shall be painted, Schedule 40 black steel and shall have threaded or welded connections. All gas piping at a pressure of 1 psig or higher within the building shall be welded. All gas piping 3-inch and larger shall be welded.
3. Use "butt welded" fittings for welded steel pipe connections.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install plumbing fixtures complete with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before plumbing fixtures Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 22 05 93, Disinfection of Plumbing Systems.
 - 3. Section 22 07 19, Plumbing Piping Insulation.
 - 4. Section 22 13 16, Sanitary Waste and Vent Piping.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/ASME A112.19.1, Enameled Cast Iron and Enameled Steel Plumbing Fixtures.
 - 2. ANSI/ASME A112.19.2, Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals.
 - 3. ANSI/ICC A117.1, Accessible and Usable Buildings and Facilities.
 - 4. AWWA C651, Disinfecting Water Mains.
 - 5. FS WW-P-541/1, Plumbing Fixtures (Water Closets).
 - 6. FS WW-P-541/8, Plumbing Fixtures-Land Use.
 - 7. USEPA WaterSense Label.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Shall have minimum of five years' experience producing equipment substantially similar to that required, and shall be able to document evidence of at least five installations in satisfactory operation for at least five years each.

- B. Component Supply and Compatibility:
 - 1. Obtain each type of plumbing fixture included in this Section, regardless of component manufacturer, from one plumbing fixtures and trim manufacturer.
 - 2. Each plumbing fixtures and trim manufacturer shall review and approve, or shall prepare, all Shop Drawings and other submittals for components furnished under this Section for the particular fixture type.
 - 3. Materials and equipment shall be suitable for the required service conditions and shall be integrated into each assembly by the associated plumbing fixtures and trim manufacturer.
- C. Regulatory Requirements: Comply with Laws and Regulations, including the following.
 - 1. National Fire Protection Association.
 - 2. ADAAG, Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities.
 - 3. Local and State Plumbing and Building codes.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Schedule of plumbing fixtures and trim for the Project, indicating for each the installation location, model or type, and other distinguishing information.
 - b. Drawings showing fabrication methods, assembly, accessories, installation details and wiring diagrams.
 - c. Detailed installation drawings of each individual components showing:
 - 1) Mounting requirements.
 - 2) Piping and roughing connections, labeled and coded.
 - 3) Instructions.
 - 4) Materials of construction.
 - 5) Data sheets.
 - d. Detailed description of each component.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
- B. Informational Submittals: Submit the following:
 - 1. Manufacturer's Instructions:
 - a. Special shipping, storage and protection, and handling instructions.
 - b. Installation data for the equipment, including setting drawings, templates, and directions for installing anchorage devices.
 - 2. Field Quality Control:
 - a. Submit results of bacteriological testing.

3. Qualifications Statements:
 - a. Manufacturer, when submittal of qualifications is required by ENGINEER.
- C. Closeout Submittals: Submit the following:
 1. Operations and Maintenance Data:
 - a. Submit in accordance with Division 1, Operations, Maintenance and Warranty Manuals.
 - b. Include maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
 2. Comply Division 1, Materials and Equipment.
- B. Storage and Protection:
 1. Store materials and equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
 2. Comply with Division 1, Materials and Equipment.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General:
 1. Exposed valves and escutcheons shall be chrome plated.
 2. Where applicable, materials and equipment furnished shall comply with FS WW-541/8.
 3. Provide materials and equipment with USEPA WaterSense label, when products with label are available from at least one manufacturer.
- B. Water Closet, Handicapped (WC):
 1. Products and Manufacturers: Provide one of the following:
 - a. American Standard, Fig. No. 3461.712.
 - b. Zurn, Fig. No. Z5665 HET.
 - c. TOTO, Fig. No. CT705ELN.
 - d. Or equal.
 2. Type: Flush-valve, siphon jet, high efficiency type, 1.28 gallons per flush.
 3. Style: Floor-mounted, bottom outlet elongated bowl.
 4. Standards: Comply with ANSI/ASME A112.19.2 and ANSI/ICC A117.1.
 5. Accessories:

- a. Flush Valve and Vacuum Breaker:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Sloan, "Crown" Model No. 111-1.28.
 - b) TOTO, Model TMT1LN32#CP.
 - c) Or equal.
- b. Seat and Cover:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Church Corporation, #9500C.
 - b) Kohler, Fig. No. K-4666-C.
 - c) Or equal.
 - 2) Standards: Comply with FS WW-P-541/1, Type IV, Class 2.
 - 3) Type: Solid plastic, elongated, open front.
 - 4) Color: White.
- c. Supply with Stop:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Kohler, Model 7637.
 - b) Cambridge Brass, Model 47T326.
 - c) Or equal.
 - 2) Type: Heavy pattern angle type water closet supply, cast body, removable burnished aluminum handle, lock shield structure, 3/8-inch IPS brass supply nipple, wall flange, long flexible tube riser, vandal-resistant lock shield when handle removed.

C. Lavatory, handicapped (LAV):

- 1. Products and Manufacturers: Provide one of the following:
 - a. Eljer, Fig. No. 051-2344.
 - b. Kohler, Fig. No. K-2054.
 - c. Or equal.
- 2. Type: Flat slab, front overflow for concealed arm support.
- 3. Material: Vitreous china.
- 4. Size: 20-inch wide by 18-inch deep.
- 5. Faucets:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Chicago Faucets, Model 420-CP.
 - 2) Delta Faucet Company, Model 511 HGM HDF.
 - 3) Or equal.
 - b. Type: Four-inch centerset faucet, aerator and single lever control.
 - c. Inlets: 1/2-inch diameter male threaded with coupling nuts.
 - d. Outlet: 0.5 gpm vandal-resistant, pressure compensating outlet.
 - e. Material: Chrome plated brass.
 - f. Flow Restrictor:
 - 1) Manufacturers: Provide products of one of the following:
 - a) Dole Energy Controls.
 - b) Eaton Corporation, Controls Division.
 - c) Or equal.
 - 2) Type: Provide 0.5 gpm flow controllers on each hot- and cold-water supply to each lavatory.
- 6. Supplies:

- a. Products and Manufacturers: Provide one of the following:
 - 1) Eljer, Model 802-0320.
 - 2) Kohler, Model K-7606-3/8-inch.
 - 3) Or equal.
 - b. Description: Lavatory supply assembly, 3/8-inch diameter angle valve, wheel handle, inlet 3/8-inch diameter male threads, escutcheon, with set screw flexible tube riser 3/8-inch diameter by 12.75-inch long.
 - c. Material: Chrome plated brass.
 - d. Accessories: 1/2-inch coupling nuts for supply connection to faucet inlets.
7. Drain Plug:
- a. Products and Manufacturers: Provide one of the following:
 - 1) Eljer, Model 803-0552.
 - 2) Kohler, Model K-7715.
 - 3) Or equal.
 - b. Description: Cast grid strainer with 1.25-inch tailpiece assembly, chrome-plated.
8. Trap:
- a. Products and Manufacturers: Provide one of the following:
 - 1) Eljer, Model 804-1185.
 - 2) Kohler, Model K-8999.
 - 3) Or equal.
 - b. Description: Adjustable cast brass "P" trap with cleanout. Slip joint inlet and 17-gage tubing outlet to wall with escutcheon, 1.25-inch inlet by 1.5-inch outlet, chrome finish.
9. Carrier:
- a. Products and Manufacturers: Provide one of the following:
 - 1) Jay R. Smith, Fig. No. 700-E.
 - 2) Zurn Industries, Fig. No. Z-1231 with 2-inch escutcheon.
 - 3) Or equal.
 - b. Description: Floor-mounted concealed arm carrier for flat slab lavatories with chrome-plated escutcheons.
10. Mixing Valve (As required by local Plumbing Code):
- a. Products and Manufacturers: Provide one of the following:
 - 1) Watts Series MMV.
 - 2) Zurn Model ZW1070.
 - 3) Or equal.
 - b. Type: Point-of-use thermostatic mixing valve.
 - c. Inlets: 1/2-inch female NPT.
 - d. Material: Bronze.
 - e. Standards Compliance: ASSE 1070.
11. Insulation: As specified in Section 22 07 19, Plumbing Piping Insulation.

D. Service Sink (SS):

- 1. Products and Manufacturers: Provide one of the following:
 - a. Kohler, Fig. No. K-6716-0.
 - b. American Standard, Fig. No. 7695.008.
 - c. Or equal.

2. Type: 24" x 20-1/4" Acid resistant enameled cast-iron single basin service sink with rim guard, drilled back on 8" centers.
 3. Accessories:
 - a. Trap Standard:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Kohler, Fig. No. K-6673.
 - b) American Standard, Fig. No. 7798.030.
 - c) Or equal.
 - 2) Type: Cast iron "P" trap for 3" iron pipe, rubber washer, inlet strainer and cleanout plug.
 - b. Faucet:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Kohler, Fig. No. K-8908.
 - b) American Standard, Fig. No. 8344.012.
 - c) Or equal.
 - 2) Description: Exposed service sink faucet with vacuum breaker, integral stops, lever or four-arm handles, spout with pail hook and 3/4" hose end, and top single brace, 1/2-inch diameter IPS female couplings and renewable seats.
 - 3) Contractor shall fabricate and mount a spacer securely anchored to wall above sink, as required, to facilitate attachment of faucet top brace at proper angle in accordance with manufacturer's installation instructions. All materials and hardware for the spacer assembly shall be hot-dip galvanized steel.
 - c. Carrier:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Jay R. Smith, Fig. No. 0871.
 - b) Zurn Industries, Fig. No. Z-1229.
 - c) Or equal.
 - 2) Description: Floor-mounted heavy-duty carrier with hanger plate, adjustable supporting and bearing studs, structural uprights and block bases secured to concrete slab with stainless steel expansion type inserts for service sinks.
 4. Standards: Comply with ANSI/ASME A112.19.1.
- E. Electric Water Cooler (EWC):
1. Products and Manufacturers: Provide one of the following:
 - a. Elkay Manufacturing Company, Model FD70051Z.
 - b. Halsey Taylor, Model S300-2E.
 - c. Or equal.
 2. Style: Floor mount freestanding electric water cooler.
 3. Capacity: 3 gal/hr for 50°F chilled drinking water.
 4. Materials:
 - a. Fountain: Satin-finish stainless steel.
 - b. Fountain Cabinet: Louvered enameled steel.
 6. Lead-containing parts in water stream are unacceptable. Provide lead reduction filter in waterline.
 7. Refrigeration Unit:

- a. Compressor: Hermetically sealed, thermal overload protection, vibration eliminators.
 - b. Electrical Characteristics: 115 volt, 60-cycle, single-phase operation, 230W, 3.5 F.L. amps.
 - c. Refrigerant: R134a
- 8. Reference:
 - a. ASME A112.19.3/CSA B45.4
 - b. NSF 61/NSF 372 (lead free)
 - c. UL 399
- F. Shower (SH): Shower Head, Valve, and Spray Handle for Handicapped Showers:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Leonard Valve Company, Surfashower, Model SS-PAM-202-D2L/501P(G)-30-VX.
 - b. Symmons Hydapipe, Model 1-903S-FSB.
 - c. Or equal.
 - 2. Type: Surface mounted shower system with thru-ceiling piping configuration. Pressure-balanced mixing valve, adjustable spray shower head, hand spray unit with flexible hose, wall hook, glide rail wall connection, and diverter with volume control for shower head and hand spray.
 - 3. Materials and Construction:
 - a. Cover Panel: all stainless steel construction. Panel shall extend up to ceiling to completely cover supply pipes.
 - b. Shower Valve: ASSE 1016 Listed, pressure actuated shower mixer with integral checkstops. Adjustable high temperature limit stop.
 - c. Shower Head:
 - 1) Chrome-plated brass.
 - 2) Description: Adjustable spray, ball joint.
 - 3) Flow Rate: 2.5 gpm.
 - d. Hand Spray: 69" braided stainless steel flex hose on 30" glide rail, wall hook, wall connection, inline double check valve backflow preventer, with lever handle.
 - e. Shower Base: Shower base shall be one-piece precast terazzo 3.5 feet by 3.5 feet square, of black and white marble chips in white portland cement rated at 3,000 psi seven days after casting. Grind and polish surface to smooth finish. Shower receptor shall have integral stainless steel entry cap suitable for wheelchair accessibility in accordance with ANSI/ICC A117.1 and ADAAG. Receptor shoulder shall not be less than four inches high inside and six inches high outside and not less than three inches wide. Tiling flange shall be cast integrally and extend minimum of one inch above shoulder on three sides of receptor. Shower receptor shall have two-inch diameter floor drain Type 1 cast integrally, in accordance with Section 22 13 16, Sanitary Waste and Vent Piping. Shower receptor shall be Model WTR-4990, manufactured by Fiat Products, or equal.
 - 4. Accessories: Provide integral service stops, soap dish.

2.2 FINISHING

- A. Factory-paint ferrous surfaces in accordance with Section 09 91 00, Painting. Do not paint porcelain, china, enameled surfaces, stainless steel, brass, chrome-plated, and other finished surfaces.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests:
 - 1. Factory-test equipment ensure that entire equipment system is properly fabricated and assembled, that all controls function as specified in accordance with the Contract Documents, and that equipment complies with the Contract Documents and approved Shop Drawings and approved CONTRACTOR's other submittals.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
 - 1. Thoroughly clean materials, equipment, and accessories prior to installation.
 - 2. Install items as in accordance with the Contract Documents, Laws and Regulations, manufacturer's recommendations, and good practice. Obtain interpretation from ENGINEER if manufacturer's instructions or Laws or Regulations conflict with the Contract Documents.
 - 3. Do not modify structures or facilities to facilitate installation of fixtures without approval of ENGINEER.
 - 4. Provide each fixture with shut off valves or stops for required water supplies.
- B. Installation of Specific Fixture Types:
 - 1. Handicap Fixtures:
 - a. Provide insulation for all plumbing piping under handicapped lavatories.
 - b. Install the following with vertical distance of 17" to 19" from floor to top of seat:
 - 1) Water Closet, Handicapped – Type WC

3.3 FIELD QUALITY CONTROL

- A. Field Tests:
 - 1. ENGINEER shall witness field tests.
 - 2. Operating Tests:
 - a. Fill all systems and verify that equipment, fixtures, valves, and appurtenances operate successfully.
 - b. Load-test in accordance with manufacturer recommendations each wall-hung fixture after installation.
 - 3. For materials and equipment that do not successfully pass field tests, make repairs or modifications and retest until acceptable results are achieved.

3.4 ADJUSTING AND CLEANING

- A. Adjusting:
 - 1. Adjust all controls for proper settings.
 - 2. While system is operable, balance all equipment, including valves, appurtenances, and similar equipment, to achieve design conditions.
- B. Cleaning:
 - 1. Upon completion of the Work, remove all labels, and remove dirt, grease, markings, and other objectionable matter from fixtures and trim.
 - 2. In preparation for painting, remove dirt, rust, dust, and objectionable materials from materials and equipment.

3.5 DISINFECTING

- A. Prior to placing potable water system into service, disinfect equipment, piping, and accessories in accordance with Section 22 05 93, Disinfection of Plumbing Systems.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC DUCTWORK, PIPING, AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install hangers and supports complete with required appurtenances for HVAC ductwork, piping, and equipment.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the hangers and supports for HVAC ductwork, piping, and equipment Work.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 05 33, Anchor Systems.
 - 3. Section 05 12 00, Structural Steel Framing.
 - 4. Section 05 50 13, Miscellaneous Metal Fabrications.
 - 5. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

- A. American National Standards Institute (ANSI).
 - 1. ANSI B1.1 – Unified Inch Screw Threads (ASME B1.1).
- B. American Society of Civil Engineers (ASCE).
 - 1. ASCE 7 – Minimum Design Loads for Buildings and Other Structures.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A47/A47M – Standard Specification for Ferritic Malleable Iron Castings.
 - 3. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 6. ASTM A575 – Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.

7. ASTM A668/A688M – Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
- D. American Welding Society (AWS).
 1. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.
- E. Federal Specifications (FS).
 1. FS WW-H-171 – Hangers and Supports, Pipe.
- F. Manufacturers Standardization Society (MSS).
 1. MSS SP 58 – Pipe Hangers and Supports-Materials, Design and Manufacture.
 2. MSS SP 69 – Pipe Hangers and Supports - Selection and Application.
- G. National Fire Protection Association (NFPA).
 1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
- H. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
 1. HVAC Duct Construction Standards – Metal and Flexible.
 2. Seismic Restraint Manual: Guidelines for Mechanical Systems.
 3. Thermoset FRP Duct Construction Manual.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
 2. Professional Engineer:
 - a. Engage a registered professional engineer legally qualified to practice in the State of Connecticut and experienced in providing engineering services of the kind indicated.
 - b. Submit qualifications data.
 - c. Responsibilities include but are not necessarily limited to:
 - 1) Carefully reviewing system performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
 - 3) Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result interpretation and a comprehensive engineering analysis verifying compliance of the system with the requirements of the Contract Documents.

- 4) Signing and sealing all calculations and design drawings, and Shop Drawings.
- 5) Certifying that:
 - a) it has performed the design of the system in accordance with the performance and design criteria stated in the Contract Documents, and
 - b) the said design conforms to all applicable local, state and federal codes, rules and regulations, and to the prevailing standards of practice.
3. Installer:
 - a. Engage an experienced installer to perform the work of this Section who has specialized in installing hangers and supports for HVAC ductwork, piping, and equipment similar to that required for this Project and who is acceptable to manufacturer.
 - b. Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.
 - 2) Approximate contract cost of the hangers and supports for HVAC ductwork, piping, and equipment.
 - 3) Amount of area installed.
4. Welding:
 - a. Qualify processes and operators in accordance with AWS B2.1 as appropriate for material to be welded.
 - b. Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single hangers and supports for HVAC ductwork, piping, and equipment manufacturer.
2. Require the hangers and supports for HVAC ductwork, piping, and equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the hangers and supports for HVAC ductwork, piping, and equipment manufacturer.

C. Regulatory Requirements:

1. International Building Code (IBC).
2. National Fire Protection Association (NFPA).
3. Local and State Building Codes and Ordinances.
4. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, and installation details.
 - b. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
 - c. Drawings showing floor supported components and installation arrangement.
 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - f. Other technical data related to specified material and equipment as requested by Engineer.
 3. Delegated Design Submittals:
 - a. 1/4-inch scale HVAC ductwork, piping, and equipment layouts, dimensioned to show length of runs, with all expansion joints, alignment guides, anchors and appurtenances required for proper control of HVAC ductwork, piping, and equipment forces. The drawings shall include all forces acting on the HVAC ductwork, piping, and equipment and the corresponding reactions of the compensation and anchor devices provided.
 - b. All drawings, design calculations, and a letter indicating that the hanger and support systems have been properly designed shall be signed and sealed by a registered professional engineer legally qualified to practice in the State of Connecticut.
- B. Informational Submittals: Submit the following:
1. Certificates:
 - a. Independent certification reports.
 2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 3. Source Quality Control Submittals:
 - a. Factory test reports.
 4. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.

- b. Professional Engineer, when requested by Engineer.
- c. Installer, when requested by Engineer.
- d. Welding, when requested by Engineer.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 - 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Design Criteria:
 - 1. Seismic Requirements:
 - a. All HVAC ductwork, piping, and equipment shall be provided with seismic restraints in accordance with the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, latest edition.
 - b. Seismic restraints shall be designed in accordance with the seismic provisions of the International Building Code (IBC) and ASCE 7 in conjunction with the current local Building Code to the extent that the most stringent provisions are utilized in developing the design seismic forces.
 - c. Refer to the Structural Drawings for site and structure specific seismic design criteria.
 - 2. Designs generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.

3. Accurate weight balance calculations shall be made to determine the required force at each hanger and support location and the weight load at each force concentration point.
4. Hangers and supports shall be capable of supporting and restraining HVAC ductwork, piping, and equipment in all conditions of operation. They shall allow free expansion and contraction, and prevent excessive stress resulting from transferred weight being induced into the HVAC ductwork, piping, and equipment.
5. Hangers and supports shall be designed so that they cannot become disengaged by movements of the supported HVAC ductwork, piping, and equipment.
6. Rod length shall be limited to a maximum length of eight linear feet.
7. HVAC ductwork, piping, and equipment that cannot be hung by rod and hanger arrangement shall be floor or wall supported.
8. All structural components shall be designed based on static and dynamic loads imposed by the supported HVAC ductwork, piping, and equipment and shall include a safety factor of 2 for the yield strength. Minimum angle sizes shall be 2-inch x 2-inch x 1/4-inch.
9. Load ratings, materials and installation shall be consistent with the recommendations from the latest edition of MSS SP 58, MSS SP 69, and FS WW-H-171.
10. Hanger and support design calculations for all HVAC ductwork, piping, and equipment shall be signed and sealed by a registered professional engineer legally qualified to practice in the State of Connecticut.

2.2 MANUFACTURERS

- A. Manufacturer: Provide product of one of the following:
 1. Erico International Corporation.
 2. Anvil International.
 3. Or equal.

2.3 DETAILS OF CONSTRUCTION

- A. Materials:
 1. Hangers, supports, restraints, and appurtenances located in corrosive areas shall be Type 316 stainless steel. Fiberglass reinforced plastic (FRP) hangers and supports shall be allowed for nonmetal ductwork only.
 2. Hangers, supports, restraints, and appurtenances located in non-corrosive or dusty areas shall be hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M.
 3. Hangers, supports, restraints, and appurtenances located outdoors shall be Type 316 stainless steel.
 4. Steel used for the support of uninsulated copper piping or plastic piping shall be PVC coated.
 5. Refer to the Corrosive and Non-Corrosive Area Designation Table shown on the Drawings for a list of these areas.

- B. Components of hangers and supports shall conform to the following:
1. Bolts: ASTM A307, Grade A, unless otherwise specified below.
 2. Forgings: ASTM A668/A688M.
 3. Malleable Iron: ASTM A47/A47M.
 4. Rods and Bars: ASTM A575.
 5. Threads: Unified Screw Threads, Class 2A and 2B, ANSI B1.1.
 6. Structural Steel: ASTM A36/A36M.
- C. Hanger Attachments: The following types of attachments shall be considered acceptable:
1. Adjustable Steel Clevis: FS WW-H-171E, Type 1.
 2. Steel Double Bolt Pipe Clamp: FS WW-H-171E, Type 3.
 3. Steel Pipe Clamp: FS WW-H-171E, Type 4.
 4. Adjustable Swivel Pipe Ring: FS WW-H-171E, Type 6.
 5. Adjustable Steel Band Hanger: FS WW-H-171E, Type 7.
 6. Riser Clamp: FS WW-H-171E, Type 8.
 7. Light-Duty Clevis Hanger: FS WW-H-171E, Type 12.
 8. Long Clips: FS WW-H-171E, Type 26.
 9. Offset J-Hooks: FS WW-H-171E, Type 27.
 10. Steel Pipe Covering Protection Saddle: FS WW-H-171E, Type 40A.
 11. Insulation Protection Shield: FS WW-H-171E, Type 41.
 12. Pipe Saddle Support: FS WW-H-171E, Type 37.
 13. Pipe Stanchion Saddle: FS WW-H-171E, Type 38.
 14. Pipe Saddle Support with Base: FS WW-H-171E, Type 36.
 15. Adjustable Roller Hanger: FS WW-H-171E, Type 42.
- D. Structural Attachments: The following types of attachments shall be considered acceptable:
1. Side Beam Clamp: FS WW-H-171E, Type 20.
 2. Center I-Beam Clamp: FS WW-H-171E, Type 21.
 3. Welded Steel Bracket: FS WW-H-171E, Types 32 and 33.
 4. Side Beam Bracket: FS WW-H-171E, Type 35.
- E. Hanger Rod Attachments: Use as required to complete assembly:
1. Forged Steel Clevis: FS WW-H-171E, Type 14.
 2. Adjustable Turnbuckle: FS WW-H-171E, Type 15.
 3. Forged Steel Welders Eye Nut: FS WW-H-171E, Type 17.
- F. Concrete anchorage shall be provided in accordance with Section 05 05 33, Anchor Systems.
- G. Structural steel shall be provided in accordance with Section 05 12 00, Structural Steel Framing.
- H. Miscellaneous metal fabrications shall be provided in accordance with Section 05 50 13, Miscellaneous Metal Fabrications.

2.4 SOURCE QUALITY CONTROL

A. Shop Tests:

1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that the package meets the specified performance requirements including manufacturer's data report.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 INSTALLATION

A. General:

1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
4. Installation to conform to requirements of all local and state codes.

B. Ductwork:

1. The construction and installation of hangers and supports for ductwork shall conform to the recommendations given in the SMACNA HVAC Duct Construction Standards, the SMACNA Seismic Restraint Manual, and the SMACNA Thermoset FRP Duct Construction Manual, except as specified.
2. Hanger rods shall have threaded ends.
3. All ductwork shall be supported from trapeze type hangers. No sheet metal duct hangers or straps will be allowed.
4. A pair of rods shall be provided at each duct support point.

5. For nonmetal ductwork, there shall be not less than a 1/4-inch buildup of FRP over the duct at each support. Each support shall be furnished with a 1/8-inch thick Teflon sheet to shield the duct from the support.

C. Piping:

1. Insulated pipes with vapor barriers shall have an insulation protection shield conforming to FS WW-H-171E, Type 41 tack-welded to hanger.
2. Insulated pipes without vapor barriers shall have a steel protection saddle conforming to FS WW-H-171E, Type 40A.
3. All uninsulated copper piping shall be supported by plastic coated steel pipe attachments.
4. All piping shall be braced as required, to prevent sway in any direction.
5. All insulated piping 3-inch diameter and larger shall be supported by roller hangers conforming to FS WW-H-171E, Type 42.
6. Additional supports shall be placed immediately adjacent to any change in direction.
7. Supports for Vertical Piping:
 - a. Provide riser clamp placed under hub, fitting or coupling with approved solid bearing on steel sleeve at each floor level.
 - b. Where riser clamps are used with plastic piping they shall be modified so as not to exert any compressive forces on the pipe.
 - c. Support spacing shall not exceed code requirements.
8. Allow clearances for expansion and contraction of piping.

D. Anchorages and Base Plates:

1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.
2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.3 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.4 SCHEDULES

- A. Hangers and Supports for Ductwork:

1. Spacing:
 - a. Ductwork shall be supported at distances not exceeding the spacing specified below:
 - 1) Metal Ductwork:
 - a) Maximum Spacing: 10 feet.
 - 2) Flexible and Other Factory-Made Ductwork (such as FRP):
 - a) Maximum Spacing: In accordance with the manufacturer's installation instructions.
 2. Hanger Rod Sizes:
 - a. Hanger rods shall be sized based on static and dynamic loads imposed by the supported ductwork and shall include a safety factor of 2 for the yield strength.
 - b. Rod load shall not exceed rod manufacturer's recommended capacity.
- B. Hangers and Supports for Piping:
1. Spacing:
 - a. Piping shall be supported at distances not exceeding the spacing specified below or in accordance with MSS SP 69:
 - 1) Copper Tube:
 - a) Maximum Horizontal Spacing: 6 feet.
 - b) Maximum Vertical Spacing: 10 feet.
 - 2) Copper Pipe:
 - a) Maximum Horizontal Spacing: 12 feet.
 - b) Maximum Vertical Spacing: 10 feet.
 - 3) Steel Pipe:
 - a) Maximum Horizontal Spacing: 12 feet.
 - b) Maximum Vertical Spacing: 15 feet.
 2. Hanger Rod Sizes:
 - a. Hanger rods shall be sized based on static and dynamic loads imposed by the supported piping and shall include a safety factor of 2 for the yield strength.
 - b. Rod load shall not exceed rod manufacturer's recommended capacity.
- C. Hangers and Supports for HVAC Equipment:
1. Provide spacing and hanger rod sizes in accordance with equipment manufacturer's installation instructions.

+ + END OF SECTION + +

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to perform the testing, adjusting, and balancing for HVAC as specified herein.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the testing, adjusting, and balancing for HVAC Work.
- C. Related Sections:
 - 1. Section 10 14 00, Signage.
 - 2. Section 23 09 00, Instrumentation and Control for HVAC.

1.2 REFERENCES

- A. Associated Air Balance Council (AABC).
 - 1. AABC National Standards for Total System Balance.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
 - 1. ASHRAE Handbook – Fundamentals.
- C. National Environmental Balancing Bureau (NEBB).
 - 1. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
- D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
 - 1. SMACNA HVAC Systems – Testing, Adjusting & Balancing Handbook.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Balancer:
 - a. Engage an experienced balancer to perform the work of this Section who has specialized in testing, adjusting, and balancing for HVAC systems similar to that required for this Project.
 - b. Minimum of five years of experience in testing, adjusting, and balancing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.

- c. Submit name and qualifications to Engineer along with the following information on a minimum of five successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.
 - 2) Approximate contract cost of the testing, adjusting, and balancing for HVAC Work.
 - 3) Amount of area tested, adjusted, and balanced.
 - 4) Biographical information on employee proposed to directly supervise the testing, adjusting, and balancing Work.
- B. Regulatory Requirements:
 - 1. Associated Air Balance Council (AABC).
 - 2. National Electrical Code (NEC).
 - 3. National Environmental Balancing Bureau (NEBB).
 - 4. National Fire Protection Association (NFPA).
 - 5. Underwriters Laboratories Inc. (UL).
 - 6. Local and State Building Codes and Ordinances.
 - 7. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Valve Charts:
 - 1) Frame and Glazing: 1/8-inch sheet acrylic in 8-1/2 by 11-inch extruded aluminum frame.
 - 2) Charts shall be typed with the following information for each valve:
 - a) Valve identification number.
 - b) Valve location.
 - c) Valve use.
 - d) Valve size.
 - e) Manufacturer's name and model.
 - 2. Product Data:
 - a. Data sheets with name of devices, manufacturer's name, model number, latest date of calibration, and correction factors for each testing, adjusting, and balancing instruments.
 - b. Other technical data related to specified material and equipment as requested by Engineer.
 - 3. Samples:
 - a. Valve tags with sample identification lettering.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certification by National Environmental Balancing Bureau (NEBB), Association Air Balance Council (AABC), or equal.
 - 2. Source Quality Control Submittals:
 - a. Specimen copies of report forms for Engineer's review and approval.

- 1) Forms shall be 8-1/2 by 11-inch paper for loose-leaf binding, with blanks for certification of report and listing all required testing, adjusting, and balancing requirements and ratings.
 3. Field Quality Control Submittals:
 - a. Written startup and field test reports presenting results of required field testing, adjusting, and balancing.
 - 1) Certified reports shall be in typed format on approved forms imprinted with the company's name.
 - 2) Reports shall include procedure outline used to test, adjust, and balance the systems and the types of instruments used.
 - 3) Minimum three certified copies of testing, adjusting, and balancing reports to the Engineer for review.
 - 4) Reports must be submitted to Engineer and Owner for approval prior to Owner's acceptance for responsibility.
 4. Qualifications Statements:
 - a. Balancer, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
 1. Maintenance Contracts:
 - a. Maintenance and Repair:
 - 1) Provide all labor, tools, and equipment to provide a Preventive Maintenance Program and make repairs for all equipment and controls during the One Year Correction Period after the Final Acceptance by Owner. Contractor shall provide the following services for the same period of one year:
 - a) Receive calls for all problems and take steps to immediately correct deficiencies, which may exist.
 - b) Provide a monthly inspection of all equipment, and record the findings on a checklist hereinafter specified.
 - c) Provide a Preventive Maintenance Schedule for the principle items of equipment.
 - d) Respond to Owner and make repairs for all equipment and controls within 24-hours of notification by Owner.
 - b. Check List:
 - 1) Provide a checklist and post a copy of it, where directed by the Owner.
 - 2) Include each piece of equipment specified or shown.
 - 3) Provide four columns for required quarterly inspections.
 - 4) Provide columns for the following:
 - a) Equipment condition.
 - b) Equipment operation.
 - c) Equipment lubrication.
 - d) Preventive maintenance.
 - 5) Preventive maintenance shall be performed in accordance with the manufacturer's recommendations and accepted practice.
 2. Operations and Maintenance Data:

- a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
- b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 SITE CONDITIONS

A. Environmental Requirements:

1. Testing, adjusting, and balancing for HVAC shall be performed when outside ambient conditions are approximate to the local ASHRAE Handbook – Fundamentals design conditions for heating and for cooling for all heating and cooling functions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:

1. Air Balance Instruments:

- a. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, and all other instruments and accessories as required to perform all air balance tests of HVAC equipment, ducts, registers, grilles, etc.
- b. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.

2. Hydronic Balance Instruments:

- a. Provide manometers, pressure gages, and all other instruments and accessories as required to perform all hydronic balance tests of HVAC equipment, piping, etc.

3. System Performance Measuring Instruments:

- a. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the complete HVAC system performance.

B. Performance Criteria:

1. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

2.2 ACCESSORIES

A. Balancing Sheaves and Belts:

1. Balancing sheaves and belts shall be provided for all belt driven equipment.
2. Sheaves and belts shall be provided to match construction and duty provided by the equipment manufacturer.

3. Equipment sheaves and belts replaced or not required to achieve balancing shall be submitted to the Owner as spare parts.

2.3 IDENTIFICATION

- A. All equipment and component identification, including valve tags, shall be provided in accordance with Section 10 14 00, Signage.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Heating, ventilating and air conditioning equipment and components shall be completely installed and in continuous operation, as required, to accomplish the testing, adjusting and balancing Work specified.
- B. Inspect all HVAC equipment and components for proper operation prior to testing, adjusting and balancing.
 1. Fan Belt Deflection: Not less than 1/4-inch or more than 1/2-inch.
 2. Finned Coils: Plate type fins shall be combed out with a fin comb for the appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.
- C. Pre-Startup Inspection:
 1. Verify proper equipment mounting and setting.
 2. Verify that control, interlock and power wiring is complete.
 3. Verify alignment of motors and drives.
 4. Verify proper piping connections and accessories.
 5. Verify that lubrication is completed.
- D. First Run Observations:
 1. Verify direction of rotation.
 2. Verify setting of safety controls.
 3. Monitor heat build-up in bearings.
 4. Check motor loads against nameplate data.
- E. Equipment Check:
 1. Verify proper overload heater sizes.
 2. Verify function of safety and operating controls.
 3. Verify proper operation of equipment.
 4. Report on inspection, observation and checking procedures.
- F. Promptly report defects which may affect the Work to Engineer.
- G. Should corrective measures caused by faulty installation require re-testing, adjusting and balancing, such Work shall be at no additional cost to the Owner.

3.2 APPLICATION

A. General:

1. Test, adjust, and balance all systems, ductwork, piping, etc. and their control systems in accordance with the AABC National Standards for Total System Balance, NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, SMACNA HVAC Systems - Testing, Adjusting & Balancing Handbook, or in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with Contractor. Contractor shall submit one copy of the standard procedure manual to the Engineer for their records.
2. Contractor shall provide all necessary instruments, tools, ladders, etc. to complete all testing, adjusting, and balancing Work.
3. Contractor shall assume full responsibility for safe keeping of all instruments, tools, ladders, etc. during the course of the Work.
4. Contractor shall be solely responsible for the protection and safeguarding of the Work and shall provide every protection against accidents, injury, and damage to persons and property.
5. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day's Work.
6. Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.
7. Contractor shall install additional access panels at no extra cost to the Owner, as is required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.
8. Systems shall be tested, adjusted, and balanced with clean filters and strainers.
9. Where equipment is provided with a variable speed controller (VSC) or variable frequency drive (VFD), balance the equipment first with the VSC or VFD and then with balancing dampers (air systems) or valves (hydronic systems). All systems shall be optimized through the VSC or VFD by balancing with the minimum static pressure needed to meet design flow conditions.

B. Air Systems:

1. Preliminary:
 - a. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.
2. Central Systems:
 - a. Test rpm for all equipment, including adjusting of each fan, air handling unit, and air conditioning unit to design requirements within the limits of mechanical equipment provided.
 - b. Test and record motor voltages and running amperes including motor nameplate data, and starter heater ratings for each unit as listed above.
 - c. Make pitot tube traverse of main supply, exhaust and return ducts, determine airflow at all fans and units and adjust fans and units to within five percent of design requirements.
 - d. Test and record system static pressure, suction and discharge.

- e. Test and adjust system for design outside air, (cfm).
- f. Test and adjust system for design recirculated air, (cfm).
- g. Test and record heating apparatus entering air temperatures, (dry bulb).
- h. Test and record cooling apparatus entering air temperatures, (dry bulb and wet bulb).
- i. Test and record heating apparatus leaving air temperatures, (dry bulb).
- j. Test and record cooling apparatus leaving air temperatures, (dry bulb and wet bulb).
- k. Record all fan and air handling unit speeds.
- l. Record air quantity delivered by each fan and air-handling unit.
- 3. Distribution:
 - a. Sheave and belt replacement shall be provided as the first means of accomplishing the balancing Work before volume dampers are adjusted from their initial open positions.
 - b. Adjust volume dampers, control dampers, splitter dampers, etc., to proper design airflow in main ducts, branch ducts, and zones.
- 4. Air Terminals:
 - a. Identify each air terminal as to location and determine required flow reading.
 - b. Test and adjust each air terminal to within tolerance of design requirements as listed below.
 - 1) Positive Zones:
 - a) Diffusers and Supply Air Terminals: 0 percent to +10 percent.
 - b) Exhaust and Return Air Terminals: 0 percent to -10 percent.
 - 2) Negative Zones:
 - a) Diffusers and Supply Air Terminals: 0 percent to -10 percent.
 - b) Exhaust and Return Air Terminals: 0 percent to +10 percent.
 - 3) Neutral Zones:
 - a) All Air Terminals: -10 percent to +10 percent.
 - c. Test procedure on air terminals shall include recording comparison of required airflow and observed airflow, adjustment of terminal, and recording of final airflow.
 - d. Adjust flow patterns from air terminal units to minimize drafts to the extent that the design and equipment permits.
- 5. Verification:
 - a. Prepare summation of readings of observed airflow for each system, compare with required airflow, and verify that duct losses are within specified allowable range.
 - b. Verify design airflow at fans as described above.
 - c. If determined that the air system has not been properly balanced, Contractor shall rebalance and recheck all equipment and components in the presence of the Engineer and as accepted by the Engineer.

C. Hydronic Systems:

- 1. Preliminary:
 - a. List all mechanical specifications of tested equipment and verify against the Contract Documents.
 - b. Open all valves in all lines to full open position.

- c. For each pump, verify rotation, test and record pump shut-off head, and test and record pump wide-open head.
 - d. Verify proper water level in the system.
 - e. Verify that air vents at high points of water systems are installed and operating freely.
- 2. Central Equipment:
 - a. Set pumps to provide proper flow quantity.
 - b. Observe leaving water temperatures and return water temperatures. Reset to correct design temperatures.
 - c. Record pump operating suction and discharge pressures, pump manufacturer, model number, nameplate horsepower, rpm. Determine final dynamic head and indicate flow rate (gpm) plotted on the proper curve for pump.
- 3. Distribution:
 - a. Adjust balance valves, control valves, etc., to proper design flow rates (gpm) in main piping, branch piping, and terminal units.
- 4. Terminal Units:
 - a. Upon completion of flow readings and adjustments at equipment and coils, mark all settings and record following data:
 - 1) Area that item of equipment serves.
 - 2) Equipment number corresponding to that as shown.
 - 3) Manufacturer and model number.
 - 4) Inlet water temperatures.
 - 5) Outlet water temperatures.
 - b. Observe and record pressure drop through units at set flow rate on call for full heating or cooling.
 - c. Record calculated flow rates and design flow rates through each piece of equipment.
- 5. Flow Balancing Devices:
 - a. Upon completion of adjustments mark all settings and record the following for each device:
 - 1) Upstream and downstream pressure.
 - 2) Fluid temperature.
 - 3) Specified fluid temperature.
 - 4) Calculated or measured flow rate.
 - b. If determined that the hydronic system has not been properly balanced, Contractor shall rebalance and recheck all equipment and components in the presence of the Engineer and as accepted by the Engineer.
- 6. Valve Tags:
 - a. Install valve tags and record necessary information required for valve charts for each valve.
- 7. Verification:
 - a. Record rated and actual running amperage and voltage for each pump motor.
 - b. Record total dynamic head for each pump.

D. Automatic Temperature Control System:

1. In cooperation with Section 23 09 00, Instrumentation and Control for HVAC, and the control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.
2. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by control system installer.

3.3 FIELD QUALITY CONTROL

A. Balancer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. After HVAC equipment installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - b. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Balancer's service person shall make visits to the Site as follows:
 - a. First visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of balancer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - c. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 SCHEDULES

- A. Test, adjust, and balance all HVAC equipment:
- B. Test, adjust, and balance the hydronic terminal devices, piping, and their control systems associated with all HVAC equipment:

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install HVAC piping insulation complete with accessories.
 - 2. This Work also includes:
 - a. Repairing all existing HVAC piping insulation in all areas that is damaged or displaced due to new construction by Contractor with materials and procedures identical to the existing HVAC piping insulation.
- B. Coordination:
 - 1. HVAC piping insulation shall not be installed until piping has been field tested and approved by Engineer.
 - 2. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the HVAC piping insulation Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 10 14 00, Signage.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM C411 – Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - 3. ASTM C449 – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- B. National Fire Protection Association (NFPA).
 - 1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 2. NFPA 90B – Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - 3. NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials.

- C. Underwriters Laboratories Inc. (UL).
 - 1. UL 723 – Test for Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar material and able to show evidence of at least five installations in satisfactory operation for at least five years.
 - 2. Installer:
 - a. Engage an experienced installer to perform the work of this Section who has specialized in installing HVAC piping insulation similar to that required for this Project and who is acceptable to manufacturer.
 - b. Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.
 - 2) Approximate contract cost of the HVAC piping insulation.
 - 3) Amount of area installed.
- B. Regulatory Requirements:
 - 1. National Fire Protection Association (NFPA).
 - 2. Underwriters Laboratories Inc. (UL).
 - 3. Local and State Building Codes and Ordinances.
 - 4. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, and installation details.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all material.
 - b. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - c. Other technical data related to specified material and equipment as requested by Engineer.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Independent certification reports:
 - 1) UL Label.

2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the material.
 - b. Installation Data.
3. Source Quality Control Submittals:
 - a. Factory test reports.
4. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
 - b. Installer, when requested by Engineer.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
- B. Storage and Protection:
 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store all material in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to material or components. Replace lost material or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Design Criteria:
 1. All insulation systems including covering, mastics, adhesives, sealers and facings shall have the following Fire Hazard Classifications in accordance with ASTM E84 or UL 723:
 - a. Flame Spread Index: 25 maximum.
 - b. Smoke Developed Index: 50 maximum.
 2. All insulation systems shall not flame, glow, smolder or smoke when tested in accordance ASTM C411 at service temperature of 220 degrees F.
 3. All insulation systems shall meet fire safety standards NFPA 90A, 90B, and 255 where applicable.

2.2 DETAILS OF MATERIALS

A. Fiberglass Thermal Insulation:

1. Product and Manufacturer: Provide one of the following:
 - a. Model FIBERGLAS SSL II – ASJ, as manufactured by Owens Corning.
 - b. Model Micro-Lok HP, as manufactured by Johns Manville.
 - c. Or equal.
2. Type: Heavy density sectional pipe insulation with a smooth, reinforced, wrinkle resistant all-service vapor retarder jacket and self-sealing adhesive lap.
3. Density: Minimum three pound per cubic foot.
4. Thermal Conductivity: Maximum 0.23 Btu-in/hr-ft²-degree F at 75 degrees F mean temperature.
5. Water Vapor Transmission: Maximum 0.02 perm.
6. Fittings: Molded fiberglass, or pre-cut fiberglass inserts.
7. Fittings Covers: One piece high impact polyvinyl chloride fitting covers.
8. Jointing Materials: Manufacturer's recommended adhesives and tape.
9. Valve Insulation: Miter cut nesting size covering segments of same thickness as pipeline, for insulation of valves.

B. Flexible-Elastomeric Thermal Insulation (for refrigerant piping):

1. Product and Manufacturer: Provide one of the following:
 - a. Model Armaflex Tube Insulation, as manufactured by Armacell.
 - b. Model Insul-Tube Insulation, as manufactured by K-Flex USA.
 - c. Or equal.
2. Type: Expanded close cell structure elastomeric thermal insulation.
3. Density: Minimum three pound per cubic foot.
4. Thermal Conductivity: Maximum 0.25 Btu-in/hr-ft²-degree F at 75 degrees F mean temperature.
5. Water Vapor Transmission: Maximum 0.05 perm.
6. Provide manufacturer's approved contact adhesive for sealing seams and butt joints.

2.3 ACCESSORIES

A. Aluminum Protective Jacketing:

1. Product and Manufacturer: Provide one of the following:
 - a. Model Strap-On, as manufactured by Pabco-Childers Metals.
 - b. Model Insul-Mate, as manufactured by RPR Products, Inc.
 - c. Or equal.
2. Material: Smooth aluminum (Alloy 3003 – H-14).
3. Thickness: 0.016-inch.
4. Moisture Retarder: 3-mil thick coextrusion of polyethylene and DuPont's Surlyn.
5. Fastening: Continuous modified Pittsburgh Z-lock longitudinal seam with self-gauging 2-inch built-in overlap.
6. Bands: 1/2-inch stainless steel bands with wing seals.
7. Fittings:

- a. Type: Pre-fabricated aluminum (Alloy 3003 – H-14) fittings.
- b. Thickness: 0.016-inch.

2.4 IDENTIFICATION

- A. All HVAC piping insulation identification shall be provided in accordance with Section 10 14 00, Signage.

2.5 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Material shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label.
 - b. Factory test material to ensure that the entire package has been properly fabricated and assembled, and that the package meets the specified performance requirements including manufacturer's data report.
 - c. Flame Spread.
 - d. Smoke Developed.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. All HVAC piping leaks shall be repaired prior to installation of HVAC piping insulation.
- C. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 INSTALLATION

- A. General:
 - 1. Install the material in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of material, unless approved in writing by Engineer.
 - 4. Installation to conform to requirements of all local and state codes.

- B. HVAC piping insulation shall be continuous through walls and floor openings except where walls or floors are required to be firestopped or required to have a fire resisting rating.
- C. Where hangers are in direct contact with low temperature piping the hanger and supporting rod shall be wrapped with foil-faced blanket insulation and vapor sealed. Hanger rod insulation and vapor barrier shall extend up to the rod a minimum distance equal to the diameter of the pipe.
- D. Install insulation so as to make surfaces smooth, even, substantially flush with adjacent insulation and installed in a manner to maintain the integrity of the vapor barrier.
- E. Provide insulation protection shields for insulated piping supported by pipe hangers.

3.3 CLEANING

- A. Thoroughly clean and dry all exterior surfaces of HVAC piping and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from HVAC piping insulation after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.4 PROTECTION OF EXECUTED WORK

- A. All insulation applied in one day shall have the vapor barrier applied the same day and any exposed ends shall be temporarily protected with a moisture barrier and sealed to the piping.

3.5 SCHEDULES

- A. See Schedule below for minimum insulation thickness and locations where required.

<u>Pipe Service</u> (Including Valves, Fittings, and Accessories)	<u>Pipe Size</u>	<u>Minimum Insulation Thickness</u>	<u>Location</u>
Steam	≤1-1/2 inches	1-1/2 inches	All Piping
	>1-1/2 inches	3 inches	
Hot Water	≤1-1/2 inches	1-1/2 inches	All Piping
	>1-1/2 inches	2 inches	

Chilled Water	All Sizes	1-1/2 inches	All Piping
Refrigerant	All Sizes	1-1/2 inches	All piping
Steam Condensate	$\leq 1\text{-}1/2$ inches $> 1\text{-}1/2$ inches	1-1/2 inches 3 inches	All Piping
Air Conditioning Condensate	All Sizes	1-1/2 inches	All Piping

- B. All insulated piping exposed within six feet vertically of floor or other working surface shall be covered with weatherproof aluminum [stainless steel] [rubberized] protective jacketing.
- C. All insulated piping located outdoors shall be covered with weatherproof aluminum protective jacketing.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, document and place in satisfactory operation an HVAC Monitoring and Control System (HMCS) complete and operational with all appurtenances as described herein.
2. An overview of the HMCS is summarized below.
 - a. The HMCS shall be comprised of a relay logic based control system with panel mounted switches and indicating lights for automatic and manual control of equipment as specified herein.
3. The system configuration shall be as specified herein and as described in Sequence of Operation. Some variations in the configuration will be considered provided functional constraints as intended for the various components of the system are met. Hardware required for the HMCS and for interfacing with other equipment shall be provided for a complete and integrated system regardless of whether or not the hardware is explicitly described at no cost to the Owner.
4. The Contract Documents illustrate and describe the overall functional and operational requirements. Contractor is responsible for tagging, integrating, and verifying the functionality of all HMCS components.
5. The Work also includes:
 - a. HMCS panels.
 - b. Power and control wiring and conduit: The conduit and wiring to be provided under this Work shall include the following:
 - 1) All wiring and conduit from each HMCS panel to remote instrumentation and control devices, motorized dampers, motorized valves, HVAC equipment panels, etc.
 - 2) All wiring and conduit between HVAC equipment panels and associated field devices.
 - 3) Any other HVAC device requiring control under this Work.
 - 4) Conduit layouts for these wiring requirements are not shown; Contractor shall determine the requirements based upon the arrangement of the components being furnished.
 - c. Motorized actuators including linkage kits and other accessories.
 - d. Control devices, thermostats, mounting accessories, junction boxes, face plates, wall plates, covers, mounting hardware as required.
 - e. Relays, selector switches, pushbuttons, indicating lights,
 - f. Transformers.
 - g. Power disconnects switches.

- h. Motor starters except where provided under the electrical Work.
- i. Other control devices and appurtenances, as required.
- 6. Items Furnished Under the Electrical Work:
 - a. All 3 phase power wiring and conduit.
 - b. 120 volt, single phase power wiring and conduit for the following:
 - 1) Power to HMCS panels.
 - 2) Power to single phase fans and pumps controlled from HMCS panels.
 - 3) Power wiring and conduit between electric unit heaters and associated thermostats.
 - c. Control wiring and conduit and status wiring and conduit from motor control centers to HMCS panels.
 - d. Control wiring and conduit and status wiring and conduit from Fire Alarm System panels to HMCS panels for each fire alarm zone.
 - e. Status wiring and conduit for remote alarm indication at the Plant Control System from the HMCS panel.
 - f. Smoke detectors.
 - g. Wiring and conduit where specified to be provided under the Electrical Work.

B. Coordination:

- 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the HMCS Work.

C. Related Sections:

- 1. Section 09 91 00, Painting.
- 2. Section 10 14 00, Signage.
- 3. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
- 4. Section 23 31 13, Metal Ductwork.
- 5. Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.
- 6. Section 26 05 29, Hangers and Supports for Electrical Systems.
- 7. Section 26 05 33.13, Rigid Conduits.
- 8. Section 26 05 33.33, Pull Junction and Terminal Boxes.
- 9. Section 26 05 53, Identification For Electrical Systems.

1.2 REFERENCES

A. National Electrical Code (NEC).

B. National Fire Protection Association (NFPA).

- 1. NFPA 79 – Electrical Standard for Industrial Machinery.

C. Underwriters Laboratories Inc. (UL).

- 1. UL 508A – Industrial Control Panels.
- 2. UL 873 – Temperature-Indicating and -Regulating Equipment.
- 3. UL 1449 – Surge Protective Devices.

1.3 QUALITY ASSURANCE

A. General:

1. The HMCS shall be furnished by a single Supplier who shall assume unit responsibility for providing a complete and integrated HMCS including performance and configuration.
2. The Supplier shall identify those system components that are not of their manufacture.

B. Supplier's Qualifications:

1. Shall be a financially sound firm having at least five years continuous experience in designing, implementing, supplying and supporting control systems utilizing relay logic for control of HVAC equipment at similar facilities which are comparable to the HMCS in terms of hardware, cost and complexity.
2. Shall have in existence an experienced engineering and technical staff capable of designing, implementing, supplying and supporting the HMCS and handling the submittal and training requirements.
3. Shall provide system hardware components of fully developed, field proven standardized designs and therefore shall furnish a system which is not a highly unique, custom one-of-a-kind system.
4. Shall provide standard course offerings in general control applications and in operation and maintenance of the HMCS and equipment at a facility specifically utilized for training purposes. The facility shall have been in operation continuously for the last two years.
5. Shall have a demonstrated record of prompt response to field failures.
6. Shall have a documented program of failure analysis.
7. Shall utilize a UL approved panel shop.
8. Shall have the capability to provide onsite service within a 2 hour period.

C. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single Supplier.
2. The Supplier shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the Supplier.

D. Regulatory Requirements:

1. National Electrical Code (NEC).
2. National Fire Protection Association (NFPA).
3. Underwriters Laboratories Inc. (UL).
4. Local and State Building Codes and Ordinances.
5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

E. Certifications:

1. HMCS panels shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Manufacturer's product name and model number.
 - f. Installation and mounting details, instructions and recommendations.
 - g. Service requirements.
2. HMCS Information:
 - a. System Description:
 - 1) Detailed control schematics showing system hardware configuration and identifying model numbers of system components.
 - 2) Control and failure modes.
 - 3) Input/output point listing.
 - 4) List of spare parts and test equipment.
 - b. Equipment Hardware:
 - 1) Construction details, features and procedures.
 - 2) Interconnection diagrams, including termination details.
 - 3) Plans showing equipment layout in control panels.
 - 4) Installation requirements, instructions and/or recommendations.
3. Panel and Cabinet Information:
 - a. Layout Drawings, including the following:
 - 1) Front views to scale.
 - 2) Dimensional information.
 - 3) Functional name of components mounted in and on panel.
 - 4) Product information on all panel components.
 - 5) Nameplate location and legend including text, letter size and colors to be used.
 - 6) Location of anchoring connections and holes.
 - 7) Location of external wiring connections.
 - 8) Mounting, support and installation details.
 - b. Wiring diagrams, including the following:
 - 1) Name of panel, console or cabinet.
 - 2) Wiring sizes and types.
 - 3) Terminal strip numbers.
 - 4) Color coding.

- 5) Functional name and manufacturer's designation for components to which wiring is connected.
 - c. Electrical control schematics in accordance with NFPA 79 Standards.
 4. Conduit Layout Information:
 - a. Conduit layout drawings showing proposed routing of exposed and concealed conduits.
 - b. Drawings shall show locations of pull boxes, junction boxes, and all building penetrations.
 - c. All conduits shall have proper identification as to size and quantity of wire.
 5. Detailed sequence of operation description.
 6. Motorized damper schedule which includes:
 - a. Damper size.
 - b. Design flow rate.
 - c. Pressure drop.
 - d. Location and unit served.
 7. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
 8. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 9. Other technical data related to specified material and equipment as requested by Engineer.
 10. Testing Plans, Procedures, and Testing Limitations:
 - a. Plan for performing required shop testing.
 - b. Plan for performing required field testing.
- B. Informational Submittals: Submit the following:
1. Supplier Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
 2. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
 3. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
 4. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 5. Qualifications Statements:
 - a. Supplier.

- C. Closeout Submittals: Submit the following:
1. Maintenance Services During Construction.
 2. Maintenance Services After Construction.
 3. Operations and Maintenance Data:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
 - c. The Operation and Maintenance Manuals shall include the following:
 - 1) Name, address, e-mail address and telephone number of the Supplier's local service representative.
 - 2) Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spares.
 - 3) Copy of all approved submittal information and system Shop Drawings as specified herein with corrections made to reflect actual system as tested and delivered to the Site for installation. Half-size black line reproductions shall be provided for all working drawings larger than 11 by 17-inches.
 - 4) Complete up-to-date system software documentation.
 - 5) Manufacturer's Original Copies of Hardware and Installation, Assembly and Operations Manuals for the HMCS devices. Manuals shall include the following information:
 - a) General descriptive information covering the basic features of the equipment.
 - b) Physical description covering layout and installation requirements and all environmental constraints.
 - c) Functional and operational descriptions covering the procedures for operation, start-up, shutdown, and calibration of the HMCS equipment and explaining how the various control functions are performed.
 - d) Principles of operation explaining the logic of operation; provide information covering operation to a component level.
 - e) Maintenance procedures covering checkout, troubleshooting, and servicing; checkout procedures shall provide the means to verify the satisfactory operation of equipment, troubleshooting procedures shall serve as a guide in determining faulty components and servicing procedure shall cover requirements and recommended time schedule for calibration, cleaning, lubrication and other housekeeping and preventive maintenance procedures.
 - f) Wiring, schematic and logic diagrams.
 - g) Safety considerations relating to operation and maintenance procedures.
 4. Warranty Documentation:
 - a. General warranty.

- b. Special warranties on materials and equipment.
- 5. Record Documentation:
 - a. Contractor and Supplier shall revise all system drawings, submittals and software documentation to reflect as-built conditions in accordance with the requirements of the Contract Documents.
 - b. Half-size black line prints of wiring diagrams and any program or configuration printouts applicable to each control panel shall be placed inside a clear plastic envelope and stored in a suitable print pocket or container inside each control panel.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - 2. Extra Stock Materials:
 - a. Panel touch up paint.
 - 3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Equipment shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage. Containers shall be protected against impact, abrasion, corrosion, discoloration and/or other damages.
 - 3. Clearly label contents of each container and provide information on the required storage conditions necessary for the equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:

1. Descriptions contained hereinafter are for guidance and to show the functions desired. They do not describe or specify all components required to interface equipment. All parts and equipment necessary to meet functional requirements shall be provided.
2. Contractor shall be completely responsible for the proper operation and installation of all control systems herein specified. Contractor shall be responsible for coordination of all interfaces with other equipment, contractors, and work specified in other Sections and Divisions to achieve the required control operation.

B. Design Criteria:

1. The HMCS shall be configured around relay logic.
2. Direct Digital Control (DDC), Programmable Logic Control (PLC), or any other type of microprocessor based control system shall not be permitted.
3. Digital devices such as programmable thermostats or similar devices are permitted where specified.
4. All components of the HMCS located in electrically classified areas shall be rated for use in that area.
5. All components of the HMCS shall be industrial grade, heavy duty and rated for the space in which they are installed except where hazardous rated (Class 1, Division 1 and 2) devices are specified for non-hazardous rated areas. Note that although areas of work may not be electrical classified, the intent is have hazardous rated field devices to ensure rugged, durable and corrosion resistant construction. Wiring for these devices shall not require Class 1, Division 1 or 2 wiring except where devices are located in electrically classified areas.
6. Components located in wet or corrosive areas shall be provided with suitable enclosures that are compatible with the area. Suitable exposed materials shall be Type 316 stainless steel, epoxy or Teflon coated aluminum or other similar materials approved by the Engineer. Steel, and galvanized steel are not suitable materials for exposure in corrosive areas.
7. HMCS components shall be designed for continuous service in an industrial environment. The system is to contain products of a single manufacturer, when possible, and to consist of equipment models, which are currently in production.
8. Design all logic and control loops to fail safe.
9. HMCS components shall be designed to return automatically to accurate measurement within fifteen seconds upon restoration of power after a power failure or when transferred to standby power supply.
10. Surge protection shall be provided for all instruments and all other HMCS components, which could be damaged by electrical surges.
11. Relays with interconnections to field devices shall be wired through terminal blocks. Terminals as part of the relay base are not an acceptable alternate.

12. Panel mounted instruments, switches, and other devices shall be selected and grouped for functionality and arranged to present a pleasing coordinated appearance. Similar type front of panel mounted devices shall be of the same manufacturer and model line. Engineer reserves the option to modify the front of panel mounted device locations at no cost to the Owner during shop drawing review.
13. Components furnished, including field and panel instruments, shall be tagged with the item number and nomenclature indicated as shown and/or approved on Shop Drawings.
14. Ranges and scales shall be coordinated to suit equipment actually furnished.
15. Field-mounted devices shall be protected from exposure to freezing temperatures.

C. Power Supplies:

1. All electrically powered monitoring equipment, control equipment and devices shall be suitable for operation on 115 volt ± 10 percent, 60 Hz ± 2 Hz power. If a different voltage or closer regulation is required, a suitable regulator or transformer shall be provided.
2. Design all power supplies for a minimum of 130 percent of the maximum simultaneous current draw.
3. A power on-off switch or an air circuit breaker shall be furnished for each item requiring electrical power.

D. Signal Requirements:

1. Where use of 4 to 20 mA DC, 0 to 10 VDC, or other analog type signals are required, signals shall be isolated from ground.
2. Signals shall not have a transient DC voltage exceeding 300 volts over one millisecond nor a DC component over 300 volts.
3. The system and associated input/output wiring will be used in an industrial environment where there can be high energy AC fields, DC control pulses, and varying ground potentials. The system design shall provide proper protection against interferences from all such possible situations.

E. Environmental Conditions:

1. The HMCS shall be designed and constructed for continuous operation under all environmental conditions in which the equipment is located.

F. Spare Controllers:

1. Provide sufficient spare relays within each HMCS panel in order to provide an additional 20 percent of the panel's inputs and 20 percent of the panel's outputs. These inputs/outputs shall be designated as spares.

2.2 SYSTEM SUPPLIERS

- A. The HMCS shall be furnished by a single Supplier who shall assume responsibility for providing a complete and integrated system. The following suppliers are acceptable provided they meet the requirements of the Contract Documents:
1. Siemens.
 2. Johnson Controls Inc.
 3. Or equal.

2.3 PANELS AND ENCLOSURES

- A. General Construction Requirements
1. Contractor shall provide all electrical components and devices, support hardware, fasteners, and interconnecting wiring required to make the control panels and/or enclosures complete and operational.
 2. Contractor shall locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.
 3. Components for installation on panel exterior shall be submitted for approval.
 4. Contractor shall adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.
 5. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.
 6. Contractor shall provide copper grounding studs for all panel equipment.
 7. Contractor shall provide the following convenience accessories inside of each control panel:
 - a. One 120 VAC, 20A duplex, grounding type receptacle.
 8. No device shall be mounted less than 36-inches above the operating floor level, unless otherwise specified.
 9. Panels shall be built in a UL certified panel shop and bear the UL label.
 10. Panels shall be built in accordance with the NEC Article 409, Industrial Control Panels.
- B. Identification:
1. Contractor shall provide laminated plastic nameplates for identification of panels and components mounted thereon as follows:
 - a. Nameplates shall be of 3/32-inch thick laminated phenolic type with white matte finish surface and black letter engraving.
 - b. Panel identification nameplates to have 1/2-inch high letter engravings.
 - c. Panel mounted component (e.g., control devices, indicating lights, selector switches, etc.) identification nameplates to have 1/4-inch high letter engravings.
 - d. Nameplates shall be attached to the panel face with two stainless steel self-tapping screws.

- e. Nameplate engravings shall include the instrument or equipment tag number and descriptive title.
- f. Tag all internally mounted instruments in accordance with the following requirements:
 - 1) The identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
 - 2) Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
 - 3) Identification tag shall be installed so that the numbers are easily visible to service personnel.
 - 4) Front of panel mounted instruments shall have the tag attached to rear of device.
- g. Tagging of the following items shall be accomplished with the use of adhesive plastic Brady USA, Inc. labels, or equal.
 - 1) Tag all electrical devices (e.g., relays, timers, power supplies) mounted within control panels and enclosures.
 - 2) Numerically tag all terminal blocks.
 - 3) Color code and numerically tag wiring at each end.
- h. Match Owner's existing wiring color code. Where no such code exists, color code and/or numerically code wiring as required by applicable standards. All wiring not de-energized by the panel disconnect or circuit breaker shall be orange colored wire.
- i. For all panels containing wiring not de-energized by the panel disconnect or circuit breaker, provide a warning nameplate on the front of the panel stating "WARNING ORANGE WIRING NOT DE-ENERGIZED BY PANEL DISCONNECT". The nameplate shall be orange with black 1/4-inch high letter engravings and shall be attached to the panel face with stainless steel screws and adhesive.

C. Panels and Enclosures:

- 1. General:
 - a. Panels and enclosures shall meet the NEMA requirements for the type specified.
 - b. Sizes shown are estimates. Contractor shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, and other components installed within.
- 2. General Construction Features:
 - a. Fabricate enclosures using minimum 14-gauge steel for wall-mounted enclosures. Steel shall be free of pitting and surface blemishes.
 - b. Contractor shall continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.

- c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
- d. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight edge. Out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
- e. Panel shall use pan type construction for doors.
- f. Doors shall be mounted with full length heavy-duty piano hinges with stainless steel hinge pins.
- g. Contractor shall provide oil-resistant gasket completely around each door or opening.
- h. Contractor shall provide handle-operated, oil-tight, key-lockable three point stainless steel latching system with rollers on latch-rods for easy door closing.
- i. Contractor shall use stainless steel fasteners throughout.
- j. Contractor shall provide steel print pocket with white enamel finish.
- k. Contractor shall provide enclosure mounting supports as required for wall mounting.
- l. Contractor shall provide all holes and cutouts for installation of conduit and equipment. All conduit and piping openings and all conduits shall be sealed watertight.
- m. Contractor shall completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.
- n. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surfacer, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
- o. All interior surfaces shall be painted with two coats of semi-gloss white polyurethane enamel.
- p. All exterior surfaces shall be painted with a minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by Engineer from complete selection of standard and custom color charts furnished by the manufacturer.
- q. Primer and finish paint shall be compatible and shall be a low VOC, high solids polyurethane enamel, Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin-Williams, Inc. or equal.
- r. Provide one extra quart of touch-up paint for each exterior finish color.
- 3. Control panels located in non-corrosive areas shall be NEMA 12 rated.
- 4. Control panels located in corrosive areas shall be NEMA 4X rated:
 - a. Panels shall be Type 316 stainless steel construction with a minimum thickness of 12-gauge for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.

- b. Panel shall be furnished with stainless steel screw clamp assemblies on three sides of each door.
 - c. Panels shall be furnished with rolled lip around three sides of door and along top of enclosure opening.
 - d. Panels shall be furnished with hasp and staple for padlocking.
 - e. Panels shall be provided with a clear plastic, gasketed lockable hinged door to encompass all non-NEMA 4X front of panel instruments, where NEMA 4X panel instruments are not available.
5. Control Panels located in electrically classified areas shall be NEMA 7:
- a. General: Explosion-proof control enclosures shall be used to house devices in hazardous environments. Enclosures shall be suitable for use in NEC Class 1, Groups C&D or Class II, Groups E, F & G applications and comply with UL and CSA standards.
 - b. Required Features:
 - 1) Light-weight and corrosion resistant copper-free aluminum.
 - 2) Integral, cast-on mounting lugs.
 - 3) Left side door hinges.
 - 4) Viewing windows sized to suit internally mounted components.
 - 5) Stainless steel cover bolts.
 - 6) Cad-plated steel mounting pans.
6. Electrical Systems:
- a. Control of Environment:
 - 1) Panels shall be furnished with adequately sized, automatically controlled 120 VAC strip heaters to maintain temperature 10 degrees F above ambient for condensation prevention inside panels.
 - 2) Panels shall be provided with automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure.
 - b. Internal Power Distribution:
 - 1) Panels shall be provided with an internal 120 VAC power distribution panel with number of circuits and separate circuit breakers sized as required to distribute power to the panel components. Distribution panel shall contain two spare breakers minimum.
 - c. Wiring:
 - 1) Internal wiring shall be Type MTW stranded copper wire with thermoplastic insulation rated for 600 V at 85 degrees C for single conductors, color coded and labeled with wire identification.
 - 2) For DC panel signal wiring, use No. 18 minimum AWG shielded.
 - 3) For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 Amps, use sizes required by NEC and NFPA 79 Standards.

- 4) Low voltage signal wiring and shielded wiring shall be separated from power and control wiring by a minimum of 6-inches.
 - 5) Parallel runs of wire shall be grouped or bundled using covered troughs. Maximum bundle size to be 1-inch. Troughs shall have 40 percent spare capacity.
 - 6) Wire troughs along horizontal or vertical routes shall be installed to present a neat appearance. Angled runs are not acceptable.
 - 7) Contractor shall adequately support and restrain all wiring runs to prevent sagging or other movement.
 - 8) Contractor shall terminate all field wiring using forked, insulated, crimp-on connectors (soldered type not acceptable) at 600 V rated barrier type terminal strips with screwed connections and permanently affixed numeric identifiers beside each connection. Identifiers to be self-stick plastic tape strips with permanent type, machine printed numbers. For DC field signal wiring, terminal strips shall be capable of handling No. 12 wiring (minimum).
Manufacturers: Provide products of one of the following:
 - a) Phoenix Contact.
 - b) Entrelec Swartwout.
 - c) Allen Bradley.
 - d) Or equal.
 - 9) All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.
 - 10) For internal component to component wiring only, compression type terminal blocks are acceptable.
 - 11) Contractor shall provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (e.g., DC signal and AC power).
 - 12) Contractor shall provide a separate terminal for grounding each shielded cable.
 - 13) Contractor shall use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.
 - 14) Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
 - 15) When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.
 - 16) Contractor shall provide circuit breakers to protect each circuit, with no more than six instruments on a single circuit.
 - 17) Contractor shall provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.
- d. Surge Protection:
- 1) General: Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. The protection systems shall be such that the

protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Instruments shall be housed in suitable metallic cases, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate junction box (compatible with the area designation) coupled to the enclosure.

- 2) UL 1449 listed.
- 3) Manufacturer: Provide products of one of the following:
 - a) DITEK Corporation.
 - b) Telecommunication Industries.
 - c) Joslyn.
 - d) Or equal.
7. Common, push-to-test circuitry shall be provided for each panel to simultaneously test all indicating lights, horn, and strobe on the panel using a single pushbutton.
8. Common, push-to-acknowledge circuitry shall be provided for each panel to silence the panel alarm horn. The strobe and alarm pilot lights shall remain energized until the alarm is cleared.

2.4 CONTROL RELAYS

- A. Type: General purpose, plug-in type rated for continuous duty.
- B. Coil Voltages: 24 VDC and 120 VAC as required.
- C. Contacts:
 1. Silver cadmium oxide rated not less than five amperes resistive at 120 VAC or 28 VDC continuous.
 2. For switching low energy circuits (less than 200 mADC) fine silver, gold flashed contacts rated not less than three amperes resistive at 120 VAC or 28 VDC continuous shall be provided.
- D. Relays to have clear plastic dust cover.
- E. Relays to be UL recognized.
- F. Manufacturer: Provide products of one of the following:
 1. IDEC.
 2. Potter & Brumfield.
 3. Allen-Bradley.
 4. Or equal.

2.5 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

- A. Product and Manufacturer: Provide one of the following:
 - 1. Model 800 Series, as manufactured by Allen-Bradley.
 - 2. Or equal.
- B. General:
 - 1. Selector switches, pushbuttons and indicating lights shall be provided by one manufacturer and is of the same series or model type.
 - 2. Type: Heavy-duty, oil-tight.
 - 3. Provide legend plate for indication of switch, pushbutton or light function (e.g. "OPEN/CLOSED", "ON/OFF/AUTOMATIC").
 - 4. Mounting: Flush mounted on control panel front, unless otherwise noted.
 - 5. NEMA rated to match panel in which mounted.
 - 6. Full size 30.5 mm devices.
 - 7. Refer to Section 40 78 00, Process Control Panel Instruments and Devices for button and lens colors.
- C. Selector Switches:
 - 1. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.
 - 2. Contacts:
 - a. Provide number and arrangement of contacts as required to perform intended functions specified but not less than one single pole, double throw contact.
 - b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.
 - c. Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than ten amperes resistive at 120 VAC or DC continuous.
 - d. Switch Operator: Standard black knob.
- D. Pushbuttons:
 - 1. Type: Provide momentary, dual type pushbuttons as required to perform intended functions specified and shown.
 - 2. Contacts: Comply with the requirements specified for selector switches.
- E. Indicating Lights:
 - 1. Type: Full voltage LED.
 - 2. Indicating lights shall be provided with labeled escutcheon plates identifying the light function. (e.g. "RUN", "STOP", "ALARM", "POWER").
- F. Rotary Cam Switches:
 - 1. Provide rotary cam switches with number of positions and poles as required to perform the required signal switching function specified and shown.

2. Contacts:
 - a. Gold-flashed contacts housed in mechanical contact blocks with number and arrangement of contacts as required to perform intended functions.
 - b. Contact Rating: Compatible with AC or DC through-put current of signals and devices simultaneously operated by the switch contacts, but not less than 20 amperes at 600 VAC or 250 VDC continuous.
 - c. Switch Operator: Standard black knob.

2.6 STROBE AND HORN

- A. Product and Manufacturer: Provide one of the following:
 1. NEMA 4X Rated: 400 ST/350; NEMA 7 Rated: 27X ST/31x as manufactured by Federal Signal.
 2. Or equal.
- B. General: Strobe light with horn shall be a pulsating, illuminating, multi-tone audible device used to indicate alarm at HMCS panels.
- C. Service:
 1. Non-Corrosive and Corrosive Areas: NEMA 4X construction.
 2. Electrically Classified Areas: NEMA 7 construction.
- D. Required Features:
 1. Power Required: 120 VAC, 60 Hz.
 2. Strobe Light: Minimum 250 candlepower; 360 degree pattern.
 3. Flashing Mechanism: 72 to 75 flashes per minute.
 4. Base Materials of Construction: Polycarbonate
 5. Color: Amber/Red/Blue.
 6. Base Materials of Construction: Aluminum (NEMA 4X Rated)/Cast Aluminum (NEMA 7 Rated).
 7. Mounting: Wall/Ceiling: Provide appropriate brackets and appurtenances.
 8. Decibel Output: 100 at ten feet minimum with manual volume control.

2.7 THERMOSTATS

- A. Space Thermostats (Non-Corrosive and Corrosive Environments)
 1. Product and Manufacturer: Provide one of the following:
 - a. Model WCRT-100, as manufactured by Chromalox.
 - b. Model TW155A, as manufactured by TPI Corporation.
 - c. Or equal.
 2. NEMA 4X rated.
 3. Sealed Noryl case.
 4. Shielded nickel-plated sensing bulb attached directly to thermostat enclosure.
 5. Thermostat Setpoint Range: 40 degrees F to 100 degrees F, with 2.5-degree F differential.
 6. Adjustable setpoints through dial on face.
 7. SPDT contacts rated at 120/240/277 VAC at 22 amps.

- B. Explosion-Proof Space Thermostats (Corrosive Environment)
1. Product and Manufacturer: Provide one of the following:
 - a. Model HLT-1, as manufactured by TPI Corporation.
 - b. Model B121-120-M504, as manufactured by United Electric Controls Co.
 - c. Or equal.
 2. UL Listed for NEC Class I, Division 1 hazardous locations.
 3. Explosion-proof epoxy coated aluminum construction with local mount Type 316L stainless steel immersion stem.
 4. Complete with built-in thermometer.
 5. Thermostat Setpoint Range: 40 degrees F to 100 degrees F, with 2 percent of scale deadband.
 6. External temperature adjustment via reference dial.
 7. SPDT contacts rated at 120/240/277 VAC at 22 amps.

2.8 DAMPER ACTUATORS

- A. General:
1. Seal tight electrical fittings shall be provided on NEMA 7 enclosures for the conduit between the actuator and remote panels and controls to maintain the NEMA 7 rating of the actuator. Supply of these conduit fittings shall be the responsibility of the Contractor and will not be provided by the actuator manufacturer.
- B. Type A
1. Electric, Direct Coupled (over the shaft):
 2. Proportional and two position as indicated in the Sequence of Operations.
 3. Spring return where specified.
 4. V-bolt and V-shaped cradle shaft attachment.
 5. Electronic overload or digital rotation sensing circuitry to prevent damage to actuator throughout the rotation of actuator.
 6. Spring return actuators shall be capable of either clockwise or counterclockwise spring return operation by changing mounting orientation.
 7. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mADC control input and provide a 2 to 10 VDC or 4 to 20 mADC operating range. Proportional control through a pulse width modulating signal is acceptable. Proportional control through floating (Tri-state) control is not acceptable. Actuators shall be capable of providing 2 to 10 VDC position feedback signals.
 8. 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA.
 9. Modulating actuators shall have an external, built in switch to allow the reversing of direction of rotation.
 10. External manual gear release with manual crank to allow manual positioning of shaft.
 11. Factory-mounted electrical cable and conduit fitting for connection to junction box.

12. Conforming to UL 873.
13. Actuator shall be provided with sufficient torque to open and close the device.
Provide a minimum torque of 133-in-lb.
14. 120VAC or 24VDC.
15. NEMA Type 2 housing.
16. Accessories:
 - a. Linkage kit.
 - b. Mounting bracket.
 - c. Auxiliary switches.
 - d. NEMA Type 4X enclosure in all corrosive atmospheres.
17. Manufacturer: Provide products of one of the following:
 - a. Belimo.
 - b. Or equal.

2.9 MOTORIZED CONTROL DAMPERS

- A. Refer to Section 23 31 13, Metal Ductwork for metal motorized dampers.

2.10 VENTILATION MONITORING AND ALARM STATIONS

- A. General:
 1. Ventilation Monitoring Stations (VMS) shall be installed where shown on the drawings to provide ventilation system status and alarm.
 2. Each VMS shall include the following:
 - a. "VENTILATION SYSTEM STATUS" sign
 - b. Green indicating status light with "VENTILATION SYSTEM ACTIVE" sign.
 - c. Red indicating status light with "WARNING – VENTILATION SYSTEM INACTIVE" sign.
 - d. Strobe
 - e. Horn
 3. Station shall be wall mounted with type 316 SS hardware. Mounting fittings shall be provide by the manufacturer.
 4. Refer to the Sequence of Operations specified under Article 3.3, below for operation.
- B. Indicating Lights:
 1. General: Green and Red indicating lights shall provide a visual indication of the ventilation system status.
 2. Required Features:
 - a. LED Light: Steady-burn; 60,000 hours.
 - b. Lens Color: Red and Green as indicated.
 - c. Enclosure: NEMA 7.
 - d. Power: 120 VAC.
 - e. Approvals: UL Listed for Class 1, Div 1, Groups C & D.
 - f. Dimensions: 15.63" high and 8.82" diameter.
 - g. Dome guard

3. Product and Manufacturer: Provide one of the following:
 - a. Model 27XL, as manufactured by Federal Signal.
 - b. Or equal.
- C. Strobe:
1. General: The light shall provide a visual warning in the area where a potential hazard may occur.
 2. Required Features:
 - a. Strobe Light: Rotating 360 degrees; 520,000 candlepower, 165 effective candlepower, 80 flashes per minute.
 - b. Lens Color: Amber.
 - c. Enclosure: NEMA 7.
 - d. Power: 120 VAC.
 - e. Approvals: UL Listed for Class 1, Div 1, Groups C & D.
 3. Product and Manufacturer: Provide one of the following:
 - a. Model 121X Series C, as manufactured by Federal Signal.
 - b. Or equal
- D. Horn:
1. General: The horn shall provide an audible warning in the area where a potential hazard may occur.
 2. Required Features:
 - a. Decibel Output: 100 at ten feet, minimum.
 - b. Enclosure: Cast aluminum corrosion resistant housing.
 - c. Horn Diaphragm: Stainless steel.
 - d. Enclosure: NEMA 7.
 - e. Power: 120 VAC.
 - f. Approvals: UL Listed for Class 1, Div 1, Groups C & D.
 3. Product and Manufacturer: Provide one of the following:
 - a. Model 31X, as manufactured by Federal Signal.
 - b. Or equal.
- E. Safety Sign:
1. General: Provide safety signs for mounting next to each warning light.
 2. Required Features:
 - a. Material: Rigid laminated plastic.
 - b. Sign Size: Minimum 7-inches wide by 12-inches high, 1/4-inch thick.
 - c. Letter Size: Minimum 3-inches high.
 - d. Color: Yellow background with black lettering.
 3. Manufacturer: Provide products of one of the following:
 - a. Controls Unlimited, Perry, Ohio.
 - b. Or equal.
- F. Test Switch:
1. A test switch shall be conveniently located below each VMS for the purpose of activating the audible and visual signals in order to validate their operation. The test switch shall be a momentary pushbutton switch, UL listed for use in

Division 1, Class 1, Groups C&D areas, is corrosion resistant, suitable for wall mounting and is rated at 120 VAC, 60 Hz, three amperes. The test switch shall be an Allen-Bradley Company Bulletin 800H, heavy duty pushbuttons factory assembled station or equal.

2.11 ACCESSORIES

A. Conduit and Wire:

1. Provide wire in conformance with Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.
2. Provide conduit, boxes and accessories in conformance with Section 26 05 29, Hangers and Supports for Electrical Systems; Section 26 05 33.13, Rigid Conduits; and Section 26 05 33.33, Pull Junction and Terminal Boxes.

B. Miscellaneous:

1. Provide any additional controls and appurtenances as required to provide proper equipment control and Sequence of Operations as specified in Article 3.3, below.
2. Provide all mounting accessories, as required.
3. Tubing, static pressure tips, mounting hardware, fasteners, and appurtenances shall be constructed of Type 316 stainless steel.

2.12 FINISHING

A. Shop Primer and Finish Coats:

1. Ferrous metal surfaces and appurtenances shall receive shop primer and finish coating in accordance with Section 09 91 00, Painting.
2. All gears, bearing surfaces, machined surfaces, and other surfaces that are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. Maintain coating during shipping and storage until equipment is placed into operation.

2.13 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.
- B. All electrical wiring identification shall be provided in accordance with Section 26 05 53, Identification For Electrical Systems.
- C. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per Owner standards.

2.14 SOURCE QUALITY CONTROL

A. Shop Tests [Inspections]:

1. Requirements and responsibilities:

- a. Before shipment, perform factory testing at the Supplier's facility to verify that system components are functioning properly and that they meet the functional and performance requirements of the Contract Documents. An Unwitnessed Factory Acceptance Test (FAT) shall take place and reports sent to the engineer. All personnel, equipment, facilities, temporary wiring, and incidentals required for testing shall be provided by Contractor.
 - b. Panels to be Factory Tested are:
 - 1) HMCS-1
 - c. Contractor shall coordinate dates of the factory testing and submit a Factory Testing Procedure for approval to verify that testing shall fulfill the requirements as specified herein. Submittal shall be made at least two months in advance of any scheduled testing and shall include dates of scheduled tests.
 - d. Contractor shall notify Engineer in writing at least four weeks before expected initiation of tests. Owner and Engineer reserve the right to witness test panels and enclosures. Costs shall be paid by the Contractor. If factory tests are not performed on the agreed date as a result of Contractor's or manufacturer's action, those costs will be paid by Contractor. The presence of Owner and Engineer during testing does not relieve the Contractor from conforming to the requirements of the Contract Documents and shall in no way imply acceptance of the equipment.
 - e. The Factory Test cannot begin until all related Instrumentation and HMCS shop drawings have been submitted and approved.
2. System hardware inspection and testing:
- a. All system hardware components shall be tested to verify proper operation of the equipment as standalone units. Test shall include, but not be limited to, the following:
 - 1) AC/DC power checks.
 - 2) Power fail/restart tests.
 - 3) Diagnostics checks.
 - b. Test demonstrating that all specified equipment functional capabilities are working properly.
 - c. Control panel and enclosure construction and wiring shall be checked to verify compliance with Specifications and approved shop drawings. Inspection shall include, but not be limited to, the following:
 - 1) Nameplates and tags.
 - 2) Wire sizes and color-coding.
 - 3) Terminal block spare requirements.
 - 4) Proper wiring practices and grounding.
 - 5) Enclosure flatness, finish, and color.
 - d. Three (3) sets of current, as-built drawings, for all panels and enclosures to be tested, shall be provided at the Factory Test for use by Owner and Engineer.

- e. Contractor shall coordinate with the Supplier to ensure proper verification of all input and output points, from the various instruments and other component systems, to the HMCS for successful operation. All I/O shall be tested prior to the completion of the project to the complete satisfaction of the Engineer.
- f. Contractor shall coordinate with the Supplier to test all input and output points prior to the witnessed factory test and shall provide copies of signed and certified check lists or other documentation to demonstrate the completion of I/O testing. All I/O shall be tested during the witnessed factory test. I/O testing shall include, as a minimum, the following:
 - 1) Simulate a field digital input for each input point at the terminal strip of the control panel and verify the signal presence at the terminal strip in the control panel.
 - 2) Force an output for each output point and verify the signal presence at the terminal strip in the control panel.
- 3. Factory test reports:
 - a. Any and all hardware modifications and/or corrections required as a result of testing shall be documented and completed before shipment of the panels. Panels shall not be shipped from the factory until two copies of certified factory test reports indicating results from factory test and satisfactory completion of hardware modifications and/or corrections have been submitted and approved. Factory test reports shall include the following information:
 - 1) List of tests performed.
 - 2) Certified check lists or documentation verifying all I/O has been tested, as specified above.
 - 3) Documentation verifying all panel wiring has been checked.
 - 4) List of required modifications or corrections identified during the Factory Test and corrective action taken.
 - 5) Factory test reports shall be signed and dated by an authorized representative of the system supplier.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 INSTALLATION

- A. General:
 - 1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
 - 4. Installation to conform to requirements of all local and state codes.
- B. Wall mounted space sensors/thermostats shall be installed five feet above finished floor. Wall plates and mounting hardware shall be provided as required for a complete installation.
- C. Where space sensors/thermostats are located on exterior walls provide an insulated mounting sub base. Where sensors/thermostats are located outdoors, provide sunshield enclosures.
- D. Furnish and install all mounting accessories, junction boxes, wall boxes and wall plates as required for installation of devices.
- E. Work described in this Section shall be installed, wired, circuit tested and calibrated by qualified electricians, technicians and mechanics.
- F. Contractor shall be responsible for the proper operation and installation of all HMCS's herein specified. Contractor shall be responsible for coordination of all interfaces with other equipment and Contractors to achieve the required HMCS operation.

3.3 SEQUENCE OF OPERATIONS

- A. General:
 - 1. Safety devices shall be hardwired, interlocked to operate in all modes of operation.
 - 2. Safety sequences shall override other automatic control sequences.
 - 3. Reset schedules and set points shown in Sequence of Operations are for initial programming and start-up, during system check out the reset schedules and set points shall be fine-tuned to obtain desired comfort and energy savings results. The Engineer reserves the right to make setpoint changes based on installed operating conditions, at no additional cost to the Owner.
 - 4. Automatic control functions that switch equipment on and off must be programmed with dead bands and/or time delays to prevent short cycling of equipment.
 - 5. HMCS panels shall be provided with panel mounted switches, pilot lights, and other control devices to provide automatic and manual control from the panel.

6. ON/OFF/AUTOMATIC” (O-O-A) selector switch shall start the unit when in the “ON” position, stop the unit when in the “OFF” position, and perform a specified operation when in the “AUTOMATIC” position.
7. Running equipment and open dampers/valves shall be shown in green. Stopped equipment and closed dampers/valves shall be shown in red. Alarms shall be shown in amber.
8. All relays and other devices required to provide the Sequence of Operations shall be housed within HMCS panels, except where otherwise noted.
9. A horn shall be provided at each HMCS panel. The horn shall be energized whenever the panel is in alarm.
10. All HMCS panels shall be provided with the following pilot lights:
 - a. Panel Power
 - b. General HVAC Alarm.
11. All HMCS panels shall be provided with the following switches:
 - a. Push to Test Circuitry.
 - b. Push to Silence Circuitry.
12. The following shall annunciate status at the HMCS panel:
 - a. Equipment status (e.g. running, off, etc.).
 - b. Two position motorized damper position (opened/closed).
 - c. Ventilation system status (active/inactive)
13. The following shall annunciate alarms at the HMCS panel:
 - a. Equipment Fail:
 - 1) Equipment indexed “ON” and not running.
 - 2) Control sequence not achieved.
 - b. Equipment Motor Overload.
 - c. High Temperature Alarm (air conditioned spaces).
 - 1) High space temperature: Set 5° F above space setpoint.
 - d. Low Temperature Alarm.
 - e. Dirty filter.
 - f. Damper Fail:
 - 1) Damper indexed to a position which has not been achieved (auxiliary switch not made).
 - g. Ventilation Alarm.
 - h. Packaged Equipment Fail.
14. Dampers are two positions, unless otherwise noted by “(modulating)” next to the damper mark number.
15. Motorized dampers shall be provided with sufficient torque to open and close the devices. As a result, more than one actuator may be required even though one actuator is shown. Additional actuators shall be provided at no additional cost to the Owner.
16. Each 120V damper shall be provided with a dedicated disconnect switch.
17. Provide a filter differential pressure switch for measuring the air flow resistance through filters at all filter sections. The device shall indicate differential pressure at the filter section and provide contact closure signal inputs into the HMCS. Dirty filter set points shall set by the Contractor as

recommended by the filter manufacturer and coordinated with the normal operating static as determined after approval of the air balance report.

B. Ventilation Monitoring:

1. A pressure switch associated with HV-1 and EF-1 shall provide discrete inputs for monitoring the ventilation system. Whenever the duct pressure falls below the value corresponding to the normal operating pressure of the room measured with the system energized, a ventilation alarm shall be provided.
2. Ventilation monitoring stations (VMS) shall be located where shown on the drawings to provide ventilation system status and alarm. When the pressure switches are satisfied, each VMS green indicating light shall be illuminated. When any one of the pressure switches are not satisfied, each VMS red indicating light shall be illuminated and the VMS horn shall sound.
3. VMS horn silence circuitry shall be provided at the HMCS to simultaneously silence all station horns. The alarm lights shall remain illuminated until the ventilation alarm is cleared.
4. Discrete alarm contacts from the HMCS panel shall be provided for remote alarm indication for the following:
 - a. HV-1 ventilation system fail.
 - b. EF-1 ventilation system fail.

C. Equipment Operating Descriptions:

1. HV-1 and EF-1:
 - a. HV-1 shall be controlled by an ON/OFF switch located at the HMCS panel. HV-1 shall run continuously.
 - 1) Heating Mode:
 - a) HV-1 shall be equipped with a hot water coil. A hot water three-way mixing valve shall modulate the hot water supply temperature to maintain a space setpoint temperature of 55°F
 - b. EF-1 shall be controlled by an ON/OFF/AUTO switch located at the HMCS panel.
 - c. In AUTO, EF-1 shall be interlocked with the supply fan of HV-1.
2. EF-2 and MD-EF2-1:
 - a. EF-2 shall be controlled by an ON/OFF/AUTO switch located at the HMCS panel.
 - b. In AUTO, EF-2 shall be controlled by a space mounted thermostat set to 70°F (adjustable).
 - c. MD-EF2-1 shall be interlocked to EF-2 and shall be fully open prior to EF-2 energizing.
3. EF-3 shall be controlled by an ON/OFF switch located at Restroom - 107.
4. EF-4 shall be controlled by an ON/OFF switch located at Restroom/Locker Room - 105.
5. EF-5 and MD-EF5-1:
 - a. EF-5 shall be controlled by an ON/OFF/AUTO switch located at the HMCS panel.

- b. In AUTO, EF-5 shall be controlled by a space mounted thermostat set to 70°F (adjustable).
 - c. MD-EF5-1 shall be interlocked to EF-5 and shall be fully open prior to EF-5 energizing.
- 6. EF-6:
 - a. EF-6 shall be controlled by a NEMA 4X ON/OFF switch located outside the entrance to Stair 2 – 109.
- 7. EF-7:
 - a. EF-7 shall be control by a ON/OFF/AUTO switch located at the HMCS panel.
 - b. In AUTO, EF-7 shall be control by a space mounted thermostat set to 80°F (adjustable).
- 8. OCF-1:
 - a. OCF-1 shall be controlled by an ON/OFF switch located at the HMCS panel. OCF-1 shall run continuously.
 - b. Dry contact shall be provided at the HMCS panel for OCF remote common alarm signal.
- 9. B-1 and P-1 thru P-6
 - a. B-1 shall be controlled by the factory installed boiler control panel to modulate the boiler to maintain the most efficient operating scheme to meet the required heating loads. The supply water temperature shall be reset by the boiler control indoor/outdoor reset schedule.
 - b. Supply and return water temperature sensor shall be provided by the boiler manufacturer.
 - c. An outside temperature sensor shall be provided by the boiler manufacturer.
 - d. P-1 thru P-2 shall be controlled via the boiler control panel.
 - e. P-3 thru 6 shall be controlled via the boiler and the pump control panel to provide zone control.
- 10. P-2 and IWH-1:
 - a. When IWH-1 calls for heating, P-2 shall sequence on via the boiler control panel.
- 11. P-3 and HUH-1 thru 6:
 - a. When outdoor air temperature is below 55°F, P-3 shall sequence on.
 - b. Each HUH fan shall be controlled by a space mounted temperature sensor set to maintain 55°F (adjustable) within the space.
- 12. P-4 and CUH-1 thru 3:
 - a. When outdoor air temperature is below 68°F, P-4 shall sequence on.
 - b. Each CUH fan shall be controlled by a space mounted temperature sensor set to maintain 68°F (adjustable) within the space.
- 13. P-5 and CV-1:
 - a. When outdoor air temperature is below 55°F, P-5 shall sequence on.
- 14. P-6 and HV-1:
 - a. When outdoor air temperature is below 55°F, P-6 shall sequence on.
- 15. AC-1 and AC-2:

- a. AC-1 and AC-2 shall each be controlled by a 7-day programmable thermostat set to maintain 75°F (adjustable) within the space.
- 16. AC-3
 - a. AC-3 shall be controlled by a 7-day programmable thermostat set to maintain 72°F (adjustable) within the space.
- 17. EUH 1-4
 - a. EUH shall be controlled by a space thermostat set to maintain 55°F (adjustable) within the space.

3.4 FIELD QUALITY CONTROL

A. System Checkout and Start-up

- 1. Contractor, under the supervision of the HMCS Supplier, and other component suppliers, as applicable, shall perform the following:
 - a. Check and approve the installation of all HMCS components and all wiring connections between the system components prior to placing the system into operation.
 - b. Conduct a complete system checkout and adjustment, including calibration of all instruments, checking operation functions, and testing of final control actions. When there are future operational functions included in the Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the system.
- 2. Contractor and the HMCS Supplier shall be responsible for initial operation of the HMCS and shall make all necessary modifications or replacements to ensure that the operation, monitoring and control of the HVAC systems function in the manner intended by these Specifications.
- 3. Contractor shall submit to the Engineer certified calibration reports for field instruments and devices and panel mounted devices upon completion of calibration.
- 4. Contractor shall submit to the Engineer an installation inspection report certifying that all system components have been installed correctly and are operating in the manner intended. The report shall be signed by authorized representatives of the Contractor and the HMCS Supplier.

B. Integrated System Field Test

- 1. Following checkout of the HMCS, Contractor shall perform an integrated system test to verify that all components are operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational.
- 2. Contractor shall demonstrate all Sequence of Operations in the presence of the Engineer.
- 3. The HMCS, including all field instruments shall be fully operational and shall run trouble-free for a successful test. Any defects or problems found during the integrated system test shall be immediately corrected by Contractor and the system retested to demonstrate proper operation.

C. Operational Availability Demonstration Test

1. The Operational Availability Demonstration (OAD) shall not begin until successful completion of the integrated system field test. The period of operation of the OAD shall be until a time frame has been achieved wherein the system (both hardware and software) availability meets or exceeds 99.9 percent for 2 consecutive days without system failures. If a system failure occurs during this period, the problem shall be corrected and the OAD restarted.
2. During the OAD, the system shall be available to plant operating personnel. Contractor and the HMCS Supplier shall be readily available to correct any problems with the system during the OAD. All HMCS training shall be completed prior to the commencement of the OAD.
3. The conditions listed below shall constitute system failures which are considered critical to the operability and maintainability of the system. The OAD shall be terminated if one or more of these conditions occur. Following correction of the problem, a new 2 consecutive day OAD shall begin.
 - a. Failure to repair a hardware problem within 120 consecutive hours from the time of notification of a system failure.
 - b. Recurrent hardware problems (e.g. if the same type of problem occurs three times or more).
4. The following conditions shall constitute a system failure in determining the system availability based on the equation specified below:
 - a. Failure of one or more input/output components.
 - b. Failures of any type affecting ten or more input/output points simultaneously.
 - c. Failure of any type affecting one or more sequential control strategies thereby causing a loss of the automatic control of the control variable or control sequence of operation.
 - d. Failure of power supply.
 - e. Failure of three or more primary field instruments simultaneously.
5. The system availability shall be calculated based on the following equation:
$$A = \text{TTO} / (\text{TTO} + \text{TTR}) \times 100\%$$

where:

A = System availability in percent.

TTO = Total time in operation.

TTR = Total time to repair.

6. Time to repair shall be the period between the time that Contractor is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.
 - a. Actual travel time for service personnel to get to the Site up to six hours for each incident from the time Contractor is notified of a system failure.
 - b. Time for receipt of spare parts to the Site once requested up to 24 hours for each incident. No work shall be done on the system while waiting for delivery of spare parts.

- c. Dead time shall not be counted as part of the system available period.
The dead time shall be logged and the duration of the OAD extended for an amount of time equal to the total dead time.
- 7. Completion of a 2 consecutive day period without any restarts of the OAD and with system availability in excess of 99.9 percent shall constitute acceptance of the HMCS by the Owner.
- 8. All parts and maintenance materials required to repair the system prior to completion of the OAD shall be supplied by Contractor, at no additional cost to the Owner.
- 9. During the OAD, a HMCS Malfunction/Repair Reporting Form shall be completed by Contractor to document system failures. The form shall include at a minimum, date and time of Contractor notification, arrival and repair dates and times, description of the problem, Contractor repair actions and Engineer approval signature. The HMCS Malfunction/Repair Reporting Form shall be completed by the plant personnel and Engineer to document system failures, to record Contractor notification, arrival and repair times and Contractor repair actions. Format of the form shall be developed and agreed upon prior to the start of the OAD.

3.5 SUPPLIER'S SERVICES DURING CONSTRUCTION

- A. Provide a qualified, factory-trained service person to perform the following:
 - 1. Instruct Contractor in installing equipment.
 - 2. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - 3. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
 - 4. Supplier's service person shall make visits to the Site as follows:
 - 5. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - 6. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - 7. Third visit shall be to instruct operations and maintenance personnel.
 - 8. Furnish services of Supplier's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 9. Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 10. Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 11. Technician shall revisit the Site as often as necessary until installation is acceptable.
 - 12. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.6 SUPPLIER'S SERVICES AFTER CONSTRUCTION

1. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment supplier's representative shall maintain all equipment furnished under this Section during the first year of operation.
2. Service provided shall include the following:
 - a. On-Site Service: Service intervals shall be quarterly for a minimum of 8 hours each quarter. The service duration shall be increased, as necessary by the equipment supplier's representative, taking into consideration the equipment service requirements and equipment size. Equipment supplier's representative shall indicate the service duration and service scope. Prior to the visits, the equipment supplier's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
 - 1) Provide supplier's recommended maintenance.
 - 2) Check all controls and components, and recalibrate or adjust as necessary.
 - 3) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - 4) Review and provide recommendations concerning Owner's operations.
 - 5) Replace or repair defective controls and components.
 - 6) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - 7) Provide a detailed field report to the Owner.
 - b. Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
 - 1) Telephone Technical Support.
 - 2) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

3.7 ADJUSTING

- A. While system is operable, adjust all controls for proper operation and final settings.
- B. Coordinate with Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.8 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.

- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

SECTION 23 21 13

HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install hydronic piping systems complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the hydronic piping systems Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 10 14 00, Signage.
 - 3. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
 - 4. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

1.2 REFERENCES

- A. American National Standards Institute (ANSI).
- B. American Society of Mechanical Engineers (ASME).
 - 1. ASME Boiler and Pressure Vessel Code.
 - a. Section V – Nondestructive Examination.
 - b. Section VIII – Rules for Construction of Pressure Vessels.
 - c. Section IX – Welding and Brazing Qualifications.
 - 2. ASME/ANSI B1.20.1 – Pipe Threads, General Purpose (Inch).
 - 3. ASME/ANSI B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
 - 4. ASME/ANSI B16.3 – Malleable Iron Threaded Fittings.
 - 5. ASME/ANSI B16.5 – Pipe Flanges and Flanged Fittings.
 - 6. ASME/ANSI B16.9 – Factory-Made Wrought Steel Butt welding Fittings.
 - 7. ASME/ANSI B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings.
 - 8. ASME/ANSI B16.21 – Nonmetallic Flat Gaskets for Pipe Flanges.
 - 9. ASME/ANSI B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 10. ASME/ANSI B16.24 – Cast Copper Alloy Pipe Flanges and Flanged Fittings.
 - 11. ASME/ANSI B16.39 – Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
 - 12. ASME/ANSI B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

13. ASME B40.100 – Pressure Gauges and Gauge Attachments.

C. American Society for Testing and Materials (ASTM).

1. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
4. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM B32 – Standard Specification for Solder Metal.
6. ASTM B61 – Standard Specification for Steam or Valve Bronze Castings.
7. ASTM B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
8. ASTM B88 – Standard Specification for Seamless Copper Water Tube.
9. ASTM B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.
10. ASTM B813 – Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
11. ASTM B828 – Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
12. ASTM D2665 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

D. American Welding Society (AWS).

1. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.
2. AWS B2.2 – Specification for Brazing Procedure and Performance Qualification.
3. AWS B2.3 – Specification for Soldering Procedure and Performance Qualification.

E. Military Specifications (MS).

1. MIL-F-1183 – Specification for Fittings, Pipe, Cast Bronze, Silver-Brazing.
2. MIL-V-18436 – Specification for Valves, Check: Bronze, Cast-Iron, and Steel Body.
3. MIL-V-18826 – Specification for Valves, Globe and Angle: Cast-Iron.

F. Manufacturers Standardization Society (MSS).

1. MSS SP-67 – Butterfly Valves.
2. MSS SP-70 – Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP-71 – Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP-80 – Bronze Gate, Globe, Angle and Check Valves.
5. MSS SP-85 – Gray-Iron Globe and Angle Valves, Flanged and Threaded Ends.
6. MSS SP-110 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
2. Professional Engineer:
 - a. Engage a registered professional engineer legally qualified to practice in the State of Connecticut and experienced in providing engineering services of the kind indicated.
 - b. Submit qualifications data.
 - c. Responsibilities include but are not necessarily limited to:
 - 1) Carefully reviewing system performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
 - 3) Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result interpretation and a comprehensive engineering analysis verifying compliance of the system with the requirements of the Contract Documents.
 - 4) Signing and sealing all calculations and design drawings, and Shop Drawings.
 - 5) Certifying that:
 - a) it has performed the design of the system in accordance with the performance and design criteria stated in the Contract Documents, and
 - b) the said design conforms to all applicable local, state and federal codes, rules and regulations, and to the prevailing standards of practice.
3. Installer:
 - a. Engage an experienced installer to perform the work of this Section who has specialized in installing hydronic piping systems similar to that required for this Project and who is acceptable to manufacturer.
 - b. Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.
 - 2) Approximate contract cost of the hydronic piping systems.
 - 3) Amount of area installed.
4. Welding, Brazing, and Soldering:
 - a. Qualify processes and operators in accordance with AWS B2.1, B2.2, and B2.3 as appropriate for material to be welded, brazed, or soldered.
 - b. Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

- B. Regulatory Requirements:
1. National Electrical Code (NEC).
 2. National Fire Protection Association (NFPA).
 3. Underwriters Laboratories Inc. (UL).
 4. Local and State Building Codes and Ordinances.
 5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, and installation details, including supports, expansion joints, guides and anchors.
 - b. 1/4-inch scale piping layouts, dimensioned to show length of runs, sizes, support spacing and expansion provisions.
 - c. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - f. Other technical data related to specified material and equipment as requested by Engineer.
 3. Delegated Design Submittals:
 - a. 1/4-inch scale piping layouts, dimensioned to show length of runs, with all expansion joints, alignment guides, anchors and appurtenances required for proper control of piping forces. The drawings shall include all forces acting on the hydronic piping system and the corresponding reactions of the compensation and anchor devices provided.
 - b. All drawings, design calculations, and a letter indicating that the expansion compensation system has been properly designed shall be signed and sealed by a registered professional engineer legally qualified to practice in the State of Connecticut.
 4. Testing Plans, Procedures, and Testing Limitations:
 - a. Plan for performing required field testing.
- B. Informational Submittals: Submit the following:
1. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.

- b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
- 2. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
- 3. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 4. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
 - b. Professional Engineer, when requested by Engineer.
 - c. Installer, when requested by Engineer.
 - d. Welding, Brazing, and Soldering, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
 - 1. Record Documentation:
 - a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the Work, submit "pdf" of CADD drawings showing the actual in place installation of all hydronic piping systems and equipment installed under this Section at a scale satisfactory to the Owner. The drawings shall show all piping on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 SITE CONDITIONS

A. Existing Conditions:

1. The Contract Documents show the general arrangement and extent of the Work to be completed. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions.
2. The Drawings are intended as an indication of the arrangement of equipment and piping and are as nearly correct as can be determined in advance of the actual construction of the Work. Equipment, piping and appurtenances found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:

1. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of one or more of the systems, Contractor, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.
2. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case and adequately provide for expansion and circulation and minimize the amount of space required for the same.
3. The Drawings do not show all offsets, fittings, accessories and details, which may be required. Contractor shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others," to complete the systems to the true extent of the Contract Documents.

2.2 DETAILS OF MATERIALS

A. Piping:

1. Copper:
 - a. Material:
 - 1) Type K, hard drawn temper copper tube conforming to the requirements of ASTM B88.
 - b. Joints:
 - 1) Solder:
 - a) Cast copper alloy fittings conforming to the requirements of ASME/ANSI 16.18.

- b) Wrought copper or copper alloy fittings conforming to the requirements of ASME/ANSI 16.22.
- c) Joining:
 - (1) Soldered using alloys containing less than 0.2 percent lead (Pb) as listed in ASTM B32. Soldering flux shall conform to the requirements of ASTM B813. Joint preparation and operations shall be in accordance with the requirements of ASTM B828.
 - 2) Flanged:
 - a) Cast copper alloy fittings conforming to the requirements of ASME/ANSI B16.24, 150 lb. class.
 - b) Gaskets:
 - (1) 1/8-inch thick, non-asbestos, high temperature compressed carbon fiber gasket with SBR or nitrile binder conforming to the requirements of ASME/ANSI B16.21.
 - (2) Product and Manufacturer: Provide one of the following:
 - (a) Style 9800, as manufactured by Garlock Sealing Technologies.
 - (b) Model Klingersil C-4500, as manufactured by Thermoseal Inc.
 - (c) Or equal.

2.3 ACCESSORIES

A. Unions:

- 1. Copper:
 - a. Manufacturer: Provide product of one of the following:
 - 1) Matco-Norca.
 - 2) NIBCO Inc.
 - 3) Or equal.
 - b. Reference: ASME/ANSI B16.18.
 - c. Type: Ground joint, copper alloy.
 - d. Adaptors: Thread to solder connection where required.
- 2. Steel:
 - a. Use flanges as previously specified.

B. Dielectric Unions:

- 1. Manufacturer: Provide product of one of the following:
 - a. Matco-Norca.
 - b. EPCO Sales, Incorporated.
 - c. Watts Regulator Company.
 - d. Or equal.
- 2. Reference: ASME/ANSI B16.39 and B16.42.
- 3. Type: Malleable iron and brass or bronze fitting with EPDM gasket.
- 4. Adaptors: Thread to solder connection where required.
- 5. Pressure Ratings:
 - a. Soldered Unions: 150 psig.
 - b. Threaded Unions: 250 psig.

- c. Flange Unions: 175 psig.
- 6. Temperature Rating: 300 degrees F at 50 psi water.

C. Dielectric Nipples:

- 1. Manufacturer: Provide product of one of the following:
 - a. Matco-Norca.
 - b. EPCO Sales, Incorporated.
 - c. Or equal.
- 2. Reference: ASTM A53 and ASME/ANSI B1.20.1.
- 3. Type: Nonalloy Schedule 40 steel nipple with an internal polymer sleeve that acts as an insulator to prevent electrolytic corrosion between dissimilar metals.
- 4. Pressure Rating: 150 psi maximum at 200 degrees F.

D. Valves:

- 1. General Requirements:
 - a. All valves shall have a minimum design pressure rating of 125 psi and capable of a test pressure of 200 psi.
 - b. Cast iron parts of valves shall meet the requirements of ASTM A126, Class B.
 - c. Flanged ends shall be flat-faced and have bolt circle and bolt patterns conforming to ASME/ANSI B16.1, Class 125 or ASME/ANSI B16.5, Class 150, unless specified otherwise.
 - d. All raised face flanges in conformance with ASME/ANSI B16.5, Class 150, shall be milled flat.
 - e. All castings shall be clean and sound, without defects of any kind and no plugging, welding or repairing of defects shall be permitted.
 - f. All bolt heads and nuts shall be hexagonal.
 - g. Gaskets shall be full face and in conformance with ASME/ANSI B16.21 and suitable for the service characteristics, chemical compatibility and temperature.
 - h. Stainless steel shall be used for parts of valves where no definite material is specified.
 - i. Operation of levers and gates shall be designed so that the effort required to operate the handwheel lever or chain shall not exceed 40 pounds applied at the extremity of the wheel or lever. The handwheels on valves 14-inches and smaller shall not be less than 8-inches in diameter.
 - j. Except where noted otherwise, all interior and exposed valves shall be handwheel or lever operated if the centerline of the valve operator is within six-feet of the floor or platform from which it is to be operated, and chain wheel operated if the vertical distance is greater than six-feet. Chains shall extend to within three feet from the operating floor.
 - k. All operators shall turn counter-clock wise to open. Operators shall have the open direction clearly and permanently marked. All valve operators shall be provided with the valve by the valve manufacturer. Contractor, through the valve manufacturer, shall be solely responsible for the selection of the proper operator to confirm to the operating conditions specified herein. Field calibration and testing of the operators and valves

to ensure a proper installation and an operating system shall be the responsibility of Contractor.

2. Manufacturer: Provide product of one of the following, except where specified otherwise:
 - a. Stockham Valves, a brand of the Crane Company.
 - b. Lunkenheimer Valves, a brand of the Cincinnati Valve Company.
 - c. Or equal.
3. Bronze Body Ball Valves:
 - a. Reference: ASTM B584 and MSS SP-110.
 - b. Type: Quarter turn, two-piece body with full port opening, adjustable packing glands, blow-out proof stem.
 - c. Details of Construction:
 - 1) Body: Cast bronze.
 - 2) End Cap: Cast bronze.
 - 3) Ball: Brass with hard chrome plated finish.
 - 4) Stem: Brass.
 - 5) Stem Packing: Reinforced PTFE.
 - 6) Seats: Reinforced PTFE.
 - 7) O-Rings: Viton.
4. Bronze Body Gate Valves:
 - a. Reference: ASTM B62 and MSS SP-80, Type 2.
 - b. Type: Inside screw rising stem with union bonnet.
 - c. Details of Construction:
 - 1) Body: Cast bronze.
 - 2) Bonnet: Cast bronze.
 - 3) Stem: Copper silicon bronze.
 - 4) Disc: Bronze.
 - 5) Union Ring: Bronze.
 - 6) Packing Ring: Graphite, non-asbestos.
 - 7) Packing Nut: Brass or bronze.
5. Bronze Body Globe Valves:
 - a. Reference: ASTM B61 and MSS SP-80, Type 1.
 - b. Type: Inside screw rising stem with union bonnet and regrinding seat.
 - c. Details of Construction:
 - 1) Body: Cast bronze.
 - 2) Bonnet: Cast bronze.
 - 3) Stem and Disc Stem Ring: Copper silicon bronze.
 - 4) Disc: Bronze.
 - 5) Union Ring: Bronze.
 - 6) Packing: Graphite, non-asbestos.
 - 7) Packing Nut: Brass or bronze.
6. Bronze Body Check Valves:
 - a. Reference: ASTM B61, ASTM B62, and MSS SP-80, Type 3.
 - b. Type: Horizontal swing with threaded cap.
 - c. Details of Construction:
 - 1) Body: Cast bronze.
 - 2) Disc: Brass or bronze.
 - 3) Hinge: Cast bronze.

- 4) Cap: Cast bronze.
7. Iron Body Butterfly Valves:
 - a. Reference: MSS SP-67, Type 1.
 - b. Type: Wafer body, lever operated, bubble tight shutoff.
 - c. Details of Construction:
 - 1) Body: Epoxy coated cast iron.
 - 2) Disc: Ductile iron.
 - 3) Seat: Viton.
 - 4) Shaft: Type 316 stainless steel.
 - 5) O-Ring: Buna-N.
 - 6) Bushing: PTFE.
 - 7) Lever: Malleable iron.
 - d. Lever shall have a ten position indicator plate.
8. Iron Body Gate Valves:
 - a. Reference: MSS SP-70, Type 1.
 - b. Type: Outside screw and yoke, rising stem with bolted bonnet.
 - c. Details of Construction:
 - 1) Body: Cast iron.
 - 2) Bonnet: Cast iron.
 - 3) Disc: Bronze or cast iron.
 - 4) Body Seat and Disc Seat Rings: Bronze.
 - 5) Stem and Yoke Sleeve: Manganese Bronze.
 - 6) Packing: Non-asbestos rings.
 - 7) Gland: Ductile iron or bronze.
 - 8) Handwheel: Ductile iron.
9. Iron Body Globe Valves:
 - a. Reference: MSS SP-85, Type 1 and MS MIL-V-18826.
 - b. Type: Outside screw and yoke, rising stem with bolted bonnet.
 - c. Details of Construction:
 - 1) Body: Cast iron.
 - 2) Bonnet: Cast iron.
 - 3) Disc: Bronze or cast iron.
 - 4) Body Seat and Disc Seat Rings: Bronze.
 - 5) Stem and Yoke Bushing: Manganese Bronze.
 - 6) Packing: Non-asbestos rings.
 - 7) Gland: Brass or bronze.
 - 8) Handwheel: Ductile iron.
10. Iron Body Check Valves:
 - a. Reference: MSS SP-71, Type 1 and MS MIL-V-18436.
 - b. Type: Horizontal swing with bolted cap.
 - c. Details of Construction:
 - 1) Body: Cast iron.
 - 2) Disc: Bronze or cast iron.
 - 3) Seat and Disc Rings: Bronze.
 - 4) Hinge: Bronze or cast iron.
 - 5) Cap: Cast Iron.
11. Triple Duty Valves:
 - a. Product and Manufacturer: Provide one of the following:

- 1) Model Triple Duty Valve, as manufactured by Bell & Gossett.
 - 2) Model Flo-Trex, as manufactured by Armstrong Limited.
 - 3) Or equal.
 - b. Type: Straight pattern, calibrated adjustment with the following features:
 - 1) Valve Characteristics.
 - 2) Regulation of pump discharge flow.
 - 3) Positive shut-off.
 - 4) Prevention of backflow with non-slam feature.
 - 5) Repacking under full system pressure.
 - c. Details of Construction:
 - 1) Body: Cast iron.
 - 2) Seat: Brass.
 - 3) Disc: Bronze with EPDM seat insert, spring loaded soft seat.
 - 4) Stem: Stainless steel and brass, back-seating type.
 - 5) Spring: Stainless steel.
 - 6) Packing: Teflon-graphite.
 - 7) Readout valve ports: Brass.
12. Circuit Balancing Valves:
- a. Manufacturer: Provide product of one of the following:
 - 1) Bell & Gossett.
 - 2) Armstrong Limited.
 - 3) Or equal.
 - b. Units 2-inch and Smaller:
 - 1) Type: Globe style with venturi valve body for precise flow measurement, precise flow balancing, and positive drip-tight shutoff.
 - 2) Details of Construction:
 - a) Body: Brass.
 - b) Bonnet: Brass.
 - c) Stem: Brass.
 - d) Disk: Brass.
 - e) O-Rings: EPDM.
 - f) Handwheel: Reinforced nylon (ABS).
 - g) Venturi shall have two brass metering ports with check valves and gasketed caps located on the inlet side of the valve.
 - 3) Valve shall have multi-turn, 360-degree adjustment with micrometer type indicator on handwheel. Minimum of five full 360-degree handwheel turns.
 - 4) Valve handle shall have hidden memory feature with tamper-proof balancing setting.
 - c. Units 2-1/2-inch and Larger:
 - 1) Type: Globe style valve body for precise flow measurement, precise flow balancing, and positive drip-tight shutoff.
 - 2) Details of Construction:
 - a) Body: Cast iron.
 - b) Disc: Bronze.
 - c) Seat: EPDM.
 - d) Stem: Brass.
 - e) Trim: Brass.

- f) O-Rings: Buna and EPDM.
- g) Handwheel: Reinforced nylon (ABS).
- h) Two brass metering ports with check valves and gasketed caps.
- 3) Valve shall have multi-turn, 360-degree adjustment with micrometer type indicator on handwheel. Minimum of five full 360-degree handwheel turns.
- 4) Valve handle shall have hidden memory feature with tamper-proof balancing setting.

E. Bronze Body Strainers:

- 1. Manufacturer: Provide product of one of the following:
 - a. Armstrong International, Inc.
 - b. Mueller Steam Specialty.
 - c. Or equal.
- 2. Type: Wye self-cleaning strainer.
- 3. Details of Construction:
 - a. Body: Cast bronze with machined seat and self-aligning screen.
 - b. Cap: Straight threaded gasketed cap.
- 4. Screens:
 - a. Sizes 2-inch and Smaller: 20-mesh, stainless steel with 0.031-inch diameter openings.
 - b. Sizes 2-1/2-inch: Perforated stainless steel with 0.063-inch diameter openings.
- 5. Pressure Rating: Class 125, 200 psi WOG.

F. Iron Body Strainers:

- 1. Manufacturer: Provide product of one of the following:
 - a. Armstrong International, Inc.
 - b. Mueller Steam Specialty.
 - c. Or equal.
- 2. Type: Wye self-cleaning strainer.
- 3. Details of Construction:
 - a. Body: Iron body with tapered seats in both the body and cover flange for secure screen retention.
 - b. Cap: Bolted cap with gasket.
- 4. Screens: Heavy-gauge perforated stainless steel.
 - a. Sizes 4-Inch and Smaller: 0.063-inch diameter perforations.
 - b. Sizes 5-Inch and Larger: 0.125-inch diameter perforations.
- 5. Pressure Rating: Class 125, 200 psi WOG.

G. Pressurized Expansion Tanks:

- 1. Manufacturer: Provide product of one of the following:
 - a. Bell & Gossett.
 - b. Amtrol, Inc.
 - c. Wessels Company.
 - d. Or equal.

2. Reference: Section VIII of the ASME Boiler and Pressure Vessel Code, for Unfired Pressure Vessels stamped with “U” Symbol and supplied with form “U-1” certifying National Board compliance.
3. Details of Construction:
 - a. Shell: Carbon steel.
 - b. Diaphragm: Heavy-duty butyl rubber or comparable material for intended.
 - c. Heads: Dished.
4. Maximum Operating Pressure: 125 psig.
5. Maximum Operating Temperature: 240 degrees F.
6. Finish: Factory applied primer coat.
7. Factory Charge: Precharged to 12 psig.
8. Acceptance Volume: 53 gallons.

H. Air Separators:

1. Manufacturer: Provide product of one of the following:
 - a. Bell & Gossett.
 - b. Amtrol, Inc.
 - c. Or equal.
2. Reference: Section VIII of the ASME Boiler and Pressure Vessel Code, for Unfired Pressure Vessels stamped with “U” Symbol and supplied with form “U-1” certifying National Board compliance.
3. Type: Tangential air separator and system strainer.
4. Details of Construction:
 - a. Air Separator:
 - 1) Material: Welded steel shell.
 - b. Air Collector Tube:
 - 1) Material: Stainless steel with baffle/collector tube support assembly.
 - 2) Perforations: 5/32-inch diameter.
 - 3) Open Area: 63 percent.
 - c. Strainer:
 - 1) Material: Removable galvanized steel.
 - 2) Perforations: 3/16-inch diameter.
 - 3) Open Area: 51 percent.
 - 4) Free Area: Five times the cross sectional area of the connecting pipe.
 - 5) Blowdown connection to facilitate routine cleaning of the strainer.
5. Maximum Operating Pressure: 125 psig.
6. Maximum Operating Temperature: 350 degrees F.
7. Finish: Factory applied primer coat.

I. Air Vents:

1. Type: Automatic high capacity float operated air vent.
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Model 107A, as manufactured by Bell & Gossett.
 - 2) Model 21-AR, as manufactured by Armstrong International, Inc.
 - 3) Or equal.
 - b. Details of Construction:
 - 1) Body and Bonnet: Cast-iron.

- 2) Internal Components: Stainless steel, brass, and EPDM.
 - c. Minimum Venting Capacity: 50 SCFM at 100 psig.
 - d. Maximum Operating Pressure: 150 psi.
 - e. Maximum Operating Temperature: 250 degrees F.
 - f. Connection: 3/4-inch NPT inlet with 3/8-inch NPT outlet.
 - g. Provide adaptor for tubing where required.
- 2. Type: Automatic Air Vent:
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Model AV813W, as manufactured by Watson McDaniel Company.
 - 2) Model AE30C, as manufactured by Spirax/Sarco, Inc.
 - 3) Or equal.
 - b. Details of Construction:
 - 1) Body and Cap: Brass or cast-iron.
 - 2) Float: Stainless steel.
 - 3) Valve: Viton rubber.
 - 4) Valve Seat: Stainless steel.
 - 5) Bracket and Lever Assembly: Stainless steel.
 - 6) Check Valve: Stainless steel.
 - c. Minimum Venting Capacity: 5 SCFM at 100 psig.
 - d. Maximum Operating Pressure: 116 psi.
 - e. Maximum Operating Temperature: 230 degrees F.
 - f. Connection: 3/4-inch NPT inlet with 3/8-inch NPT outlet.
 - g. Provide adaptor for tubing, where required.

J. Relief Valves:

- 1. Manufacturer: Provide product of one of the following:
 - a. Bell & Gossett.
 - b. S.A. Armstrong Limited.
 - c. Or equal.
- 2. Details of Construction:
 - a. Body: Cast iron or brass.
 - b. Diaphragm and Seat: EPDM.
 - c. Internal Wetted Parts: Brass.
 - d. Maximum Operating Pressure: 125 psig.
 - e. Maximum Operating Temperature: 250 degrees F.
 - f. ASME labeled for relieving pressure.
 - g. Low blow down differential.
 - h. Fluid shall not be permitted to discharge into the spring chamber.

K. Thermometers:

- 1. Product and Manufacturer: Provide one of the following:
 - a. Model BX9, as manufactured by H.O. Trerice Company.
 - b. Model A9VU9, as manufactured by Weiss Instruments.
 - c. Or equal.
- 2. Range:
 - a. 30 degrees F to 240 degrees F temperature range in maximum increments of 2 degrees F for hot water systems.

- b. 0 degrees F to 100 degrees F temperature range in maximum increments of 2 degrees F for chilled water systems.
- 3. Type: Adjustable Angle Column Type Thermometer.
 - a. Details of Construction:
 - 1) Case: Nine-inch smooth die cast aluminum.
 - 2) Window: Clear acrylic plastic or glass held in place with stainless steel cap.
 - 3) Tube: Lens front, magnifying type with red or blue colored organic fill.
 - 4) Scale: White background with black figures and markings.
 - 5) Stem: Brass with union connections.
 - 6) Thermowell: Industrial Type 316 stainless steel insertion well with separable socket.
 - 7) Neck: 2-1/2-inch extension neck.
 - 8) Accuracy: Within one scale division.
- 4. Plastic type casing is not acceptable.

L. Pressure Gauges:

- 1. Product and Manufacturer: Provide one of the following:
 - a. Model 500XSS, as manufactured by H.O. Trerice Company.
 - b. Model 4PGN2, as manufactured by Weiss Instruments.
 - c. Or equal.
- 2. Reference: ASME/ANSI B40.100 for Grade 2A gauges.
- 3. Range: Pressure range shall be selected such that operating pressure is at the midpoint of range:
 - a. 0 to 15 psig in maximum increments of 0.1 psig.
 - b. 0 to 30 psig in maximum increments of 0.2 psig.
 - c. 0 to 60 psig in maximum increments of 0.5 psig.
- 4. Type: Direct mounted, dial type, dry pressure gauge.
- 5. Details of Construction:
 - a. Case: 4-1/2-inch cast aluminum with black finish.
 - b. Ring: Friction type-stainless steel.
 - c. Window: Glass or clear acrylic plastic.
 - d. Dial: Aluminum, white background with black markings and graduations.
 - e. Pointer: Micrometer type with black finish.
 - f. Movement: Stainless steel rotary type.
 - g. Bourdon Tube/Socket: Type 316 stainless steel tube, welded to Type 316 stainless steel socket and tip, 1/2-inch NPT.
 - h. Accuracy: ASME/ANSI B 40.100, Grade 2A; 1/2 percent of scale range.
- 6. Gauge Valves:
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Model M25HPS, as manufactured by Anderson Greenwood, a brand of Tyco Flow Control.
 - 2) Model HB Series, as manufactured by Hex Valve.
 - 3) Or equal.
 - b. References: ASME B31.1 and ASME B31.3.
 - c. Type: Block and bleed valves.

- d. Details of Construction:
 - 1) Body: Type 316 stainless steel.
 - 2) Bonnet: Type 316 stainless steel.
 - 3) Stem: Type 316 stainless steel.
 - 4) Tee Handle: Type 316 stainless steel.
 - 5) Packing: Teflon or graphite.
- e. Maximum Operating Pressure: 2915 psi at 1000 degrees F.

M. Mechanical Link Seals:

- 1. Manufacturer: Provide product of one of the following:
 - a. Pipeline Seal and Insulator, Inc.
 - b. Thunderline Corporation.
 - c. Calpico, Inc.
 - d. Or equal.
- 2. Provide mechanical link seals through walls or floors with adjusting bolts suitable for 20 psig of pressure where shown or specified.
- 3. Details of Construction:
 - a. Non-Fire Rated Seals:
 - 1) Pressure Plates: Glass reinforced nylon composite.
 - 2) Bolts and Nuts: Type 316 stainless steel.
 - 3) Sealing Element: EPDM.
 - b. Fire Rated Seals:
 - 1) Pressure Plates: Zinc dichromate steel.
 - 2) Bolts and Nuts: Two part zinc dichromate steel with corrosion inhibiting coating.
 - 3) Sealing Element: Silicone.
 - 4) 1-1/2-hour fire rating.

N. Flexible Connections:

- 1. Manufacturer: Provide product of one of the following:
 - a. The Metraflex Company.
 - b. Mason Industries, Inc.
 - c. Or equal.
- 2. Type: Flexible connections for piping 2-1/2-inches and smaller:
 - a. Details of Construction:
 - 1) Hose: Stainless steel.
 - 2) Braid: Stainless steel.
 - b. Maximum Operating Pressure: 300 psi.
 - c. Maximum Operating Temperature: 250 degrees F.
 - d. End Connections: Screwed ends welded to hose braid ends. Provide stainless steel to copper tube adaptors.
- 3. Type: Flexible connections for piping 3-inches and larger:
 - a. Details of Construction:
 - 1) Hose: Stainless steel.
 - 2) Braid: Stainless steel.
 - b. Maximum Operating Pressure: 150 psi.
 - c. Maximum Operating Temperature: 250 degrees F.
 - d. End Connections: Flanged, welded to hose and braid ends.

O. Chainwheel Operators:

1. Shall be fabricated of Type 316 stainless steel where located in corrosive areas and hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M in non-corrosive areas. Refer to the Corrosive and Non-Corrosive Area Designation Table on the Drawings for a list of these areas.
2. Shall be pocketed type chain wheels with chain guards and guides.
3. Shall have Type 316 stainless steel smooth welded link type chain. Chain that is crimped or has links with exposed ends shall not be acceptable.
4. Shall be marked with an arrow and the word "OPEN" indicating direction to open.

P. Expansion Joints, Guides, and Anchors:

1. Contractor shall provide a system of expansion joints, alignment guides, anchors, and appurtenances as required to absorb thermal expansion within the piping system. Cold springs shall not be used as expansion joints.
2. Expansion joints, guides, anchors, and appurtenances shall be constructed of Type 316 [304] stainless steel where located in corrosive areas and hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M in non-corrosive areas. Refer to the Corrosive and Non-Corrosive Area Designation Table on the Drawings for a list of these areas.
3. Expansion joints, alignment guides, and anchors are not shown. Contractor shall provide the services of the expansion joint manufacturer to design a system of expansion compensation for all piping systems. Expansion compensation design for all piping systems shall be signed and sealed by a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located.
4. Pipe anchors shall be spaced to divide pipe into sections. Anchors shall be located at valves, changes in direction of piping, and major branch connections as required to control stresses in piping due to expansion. Anchors shall be of a type recommended by the pipe manufacturer and approved by the Engineer. Anchors shall be made of structural materials of heavy cross section and securely fastened directly or indirectly to the building construction.

Q. Sleeves and Wall Pipes:

1. General:

- a. Wall pipes and wall sleeves shall be provided in accordance with the following schedule when passing through new or existing concrete or masonry structures, except where noted otherwise:

<u>From</u>	<u>To</u>	<u>Fitting</u>
Dry area	Wet area	Wall Pipe
Dry area	Earth Exterior	Wall Pipe
Dry area	Dry area	Plain Sleeve
Earth	Earth	Plain Sleeve
Exterior	Exterior	Plain Sleeve

- b. Material of construction shall be Type 316 [304] stainless steel where located in corrosive areas and hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M in non-corrosive areas. Refer to the Corrosive and Non-Corrosive Area Designation Table on the Drawings for a list of these areas.
- 2. Sleeves:
 - a. Wall sleeves shall be Schedule 40.
 - b. Shall be of sufficient size to pass the pipe and the insulation covering the pipe.
 - c. Shall extend 2-inches above the finished floor.
 - d. Shall be provided with split type escutcheon plates at the floor and wall openings.
 - e. Shall terminate flush with walls and ceilings.
 - f. Shall not be required in existing concrete walls where walls are core drilled and the resulting hole has a smooth inside surface.
 - g. Shall be calked with a fire retardant caulking compound at firewalls and a gas tight caulking compound at gas tight walls.
- 3. Wall Pipes:
 - a. Wall pipes shall be equipped with a waterstop.
 - b. Shall be of sufficient length to pass through the wall and provide adequate clearance for fastening.
 - c. The end of the wall pipes shall be of a type consistent with the piping to be connected to them and shall conform to their standards and specifications.
 - d. All wall pipes shall have the same interior protection as specified for the connecting piping. Exterior protection shall be as specified for the yard piping.

R. Hardware:

- 1. All bolts, nuts, washers, and other fastening appurtenances shall be constructed of Type 316 [304] stainless steel where located in corrosive areas and hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M in non-corrosive areas. Refer to the Corrosive and Non-Corrosive Area Designation Table on the Drawings for a list of these areas.
- 2. Hardware shall be provided in accordance with the manufacturer's recommendations for type, size, and torque value.

S. Structural Supports:

- 1. Contractor shall provide and install all hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances as required to mount all hydronic piping systems.
- 2. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall conform to Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

2.4 IDENTIFICATION

- A. Each length of piping and fittings shall be legibly printed or identified with the name of the manufacturer.

- B. All piping and equipment identification shall be provided in accordance with Section 10 14 00, Signage.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:
 - 1. Properly plug or cap the open ends of all piping at the end of each day's Work or other stopping point through construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

- A. General:
 - 1. Install the piping and equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of piping, unless specifically approved by Engineer.
 - 4. Installation shall conform to requirements of all local and state codes.
 - 5. Contractor shall provide all labor, tools, materials, and equipment necessary for installation of the piping system. All piping shall be installed in accordance with the Contract Documents in a neat workmanlike manner and shall be set for accurate line and elevation. All piping shall be thoroughly cleaned before installation, and care shall be taken to keep the piping clean throughout the installation.
 - 6. Before setting wall sleeves, pipes, castings and pipes to be cast-in-place, Contractor shall coordinate with the Drawings and Figures, which may have a direct bearing on the pipe locations. Contractor shall be responsible for coordinating the proper location of the pipes and appurtenances during the construction with all trades.
 - 7. Piping shall be attached to pumps, valves, equipment, etc., in accordance with the respective manufacturer's recommendations.

8. For piping assembled with threaded, solvent cemented, welded or soldered joints, liberal use of unions shall be made. Unions shall be provided close to main pieces of equipment and in branch lines to permit ready dismantling of piping without disturbing main pipe lines or adjacent branch lines. A minimum of one union per straight run of pipe between fittings and/or valves with multiple lengths of pipe shall be used. Unions shall be placed downstream of the shut off or isolating valves. Where flanges are installed, unions shall be omitted.
9. All changes in directions or elevations shall be made with fittings.
10. Piping shall not run above motor control centers, control panels or other electrical equipment, unless directed by the Engineer, in writing. Piping which must run above electrical equipment shall be provided with suitable drip pans.
11. Piping shall be installed free of traps and with sufficient slope so that all of the various piping systems may be drained to one or several points. In the event that it is impossible to drain to a common point due to structural obstructions and finished ceiling heights, furnish and install all additional drain valves that may be required to completely drain piping systems. Location of all drain valves shall be approved by Engineer prior to installation.

B. Joints:

1. Threaded:
 - a. All threads shall be clean, machine cut and all pipes shall be reamed before erection.
 - b. Taps and dies shall be cleaned, sharpened and in good condition.
 - c. All threaded joints shall be made tight with suitable joint compound or material.
 - d. After having been set up, a joint shall not be backed off unless the joint is broken, the threads cleaned, and new tape is applied.
2. Flanged:
 - a. Shall be made up with full-face gaskets, as specified.
 - b. Shall have the flange faces bearing uniformly on the gaskets.
 - c. Shall have the flanges drawn together uniformly until the joint is tight.
 - d. No washers shall be permitted for the bolt and nut assemblies.
 - e. The length of the bolts shall be uniform and in accordance with the standards specified herein. The bolt's maximum projection beyond the end of the nut shall not be greater than 0.25-inch nor shall the bolt fall short of the end of the nut.
3. Welded:
 - a. Field welding shall be permitted for black carbon steel pipe in non-hazardous (non-explosive) areas only. Piping for hazardous areas shall be shop welded, brought to the Site in segments and installed using flanges.
 - b. All welding shall be performed in accordance with the requirements of AWS.

- C. Valves:
1. All valves shall be manually opened and closed before installation to check their operation, and the interior of the valves shall be cleaned. Joints shall be made as specified.
 2. Install the valves so that they can be conveniently operated. Do not place operators at angles other than parallel to the floors or walls.
 3. Valves shall be supported as integral components of the piping systems.
- D. Piping Layout in Building:
1. Water shall circulate freely with no evidence of trapping or air binding.
 2. Runouts to units above the main shall be taken off top of main.
 3. Runouts to units below the main shall be taken off bottom of main.
 4. Low points of piping shall have ball drain valves.
 5. Threaded end unions or bolted end flange connections shall be provided for removal of each piece of equipment or device without major dismantling.
 6. Allow clearances for expansion and contraction of piping.
 7. Provide flexible connectors for each pipe passing through building expansion joints.
 8. Do not block openings or passageways with piping.
 9. Install straight runs true to building line.
 10. Install vertical pipe truly plumb in all directions.
 11. Install piping parallel or perpendicular to building walls. Piping at odd angles and 45 degrees runs across corners shall not be accepted.
- E. Pressure gauge ranges shall be selected for proper sensitivity, so that the dial indicator points to the approximate center of the dial in normal operation.
- F. Provide automatic air vents with isolation ball valves at all high points of water lines and where shown.
- G. Provide nipple, 3/4-inch ball valve and short nipple with capped hose connection for each hydronic strainer blow down.
- H. Install fine mesh start-up screens in all strainers and replace with final stainless steel screens after 30 days of pump operating time.
- I. Provide all supporting steel, brackets, etc. as required to support all equipment in an approved manner.
- J. Hard pipe all drain lines, relief valve drain lines, and air vents to nearest floor drain.
- K. All thermometers shall be legible from a standing position on the floor.
- L. Provide mechanical link seals with sleeves or wall pipes at all piping penetrations through wall, roof and floor slabs.
- M. Escutcheon plates shall be provided for all exposed piping penetrations.
- 06532002.0000 23 21 13-21

- N. All connections between ferrous and non-ferrous piping materials shall be made with dielectric unions or nipples.
- O. Care shall be taken so as not to leave tool marks or abrasions on plated, polished or soft metal piping.
- P. Wherever changes in sizes of piping occur, changes shall be made with concentric reducing fittings. The use of bushings is not permitted, unless shown otherwise.
- Q. Provide shutoff valves to each piece of equipment furnished.

3.4 FIELD QUALITY CONTROL

A. Field Tests:

- 1. Contractor shall provide all necessary labor and equipment required for the field tests specified below including, but not limited to, air compressor, gauges, conduit caps, temporary pipe and connections. Contractor shall provide water for all testing and may use only water from an approved source. Contractor shall also furnish and install all means and apparatus required for getting the water into the pipeline and testing; including pumps, gauges, and meters, plugs, caps, temporary blow-off piping and bypass piping, etc., complete with any necessary reaction blocking to prevent pipe movement during the testing. All pipelines shall be flushed clean (refer to Paragraph 3.6.B) and tested in such lengths or sections as agreed upon between the Engineer and Contractor. Contractor shall provide the Engineer reasonable notice of the time when he intends to test portions of the pipelines. The Engineer reserves the right to request additional testing of any section or portion of a pipeline.
- 2. After flushing, all pipelines shall be hydrostatically tested to one and one half times the maximum system design pressure, but not less than 100 psi.
- 3. The piping shall be filled with water for a period of not less than eight hours, then subject to the indicated test pressure. During the pressure test, there shall be no leakage. All air shall be purged from the line before pressure testing. The duration of the hydrostatic test shall be eight hours.
- 4. Any leaks or defective pipe disclosed by the hydrostatic test shall be corrected by Contractor and the test repeated until passed.

B. Inspection:

- 1. Examine areas to receive piping and accessories for:
 - a. Defects that adversely affect execution and quality of the Work.
 - b. Deviations beyond allowable tolerances.
 - c. Start the Work only when conditions are satisfactory.
- 2. The Engineer reserves the right to reject or authorize replacement of piping and accessories found to be defective or deviated from allowable tolerances.

3.5 ADJUSTING

- A. All hydronic piping systems shall be adjusted and balanced per Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.6 CLEANING

- A. Contractor shall provide all necessary labor and equipment required for flushing and cleaning. Contractor shall provide water for all flushing and may use only water from an approved source. Contractor shall also furnish and install all means and apparatus necessary for getting the water into the pipeline and flushing including pumps, gauges, meters, temporary blow off piping, bypass piping, etc., complete with all required reaction blocking to prevent pipe movement during the procedure.
- B. Before placing the hydronic piping system into service, Contractor shall thoroughly clean all piping systems by thoroughly flushing with water and chemical cleaner. All debris which may have entered the pipe during the construction period shall be removed. If after this cleaning any obstructions remain, Contractor shall correct to the satisfaction of the Engineer. Pipelines shall be flushed at a rate of at least 2.5 feet per second for duration suitable to the Engineer.
- C. Cleaning methods and procedures shall be as recommended by the manufacturer of the cleaning agents and chemicals used. Chemical cleaning agents shall be as manufactured by Oakite, Nalco, Dearborn, or equal.
- D. After the cleaning period, empty all dirt pockets and clean all strainers.
- E. Remove all dirt, rust, dust, etc. from hydronic piping systems after installation.
- F. Remove and dispose of all debris and waste from the Site resulting from installation.

3.7 PROTECTION OF EXECUTED WORK

- A. Water Treatment:
 - 1. The Contractor shall engage a suitable water treatment Contractor, such as Drew Water Services, Nalco Chemical, or Betz, to provide a supervised water treatment program for a period of one year from the date of initial treatment. Services shall include the following:
 - a. Provide all equipment and chemicals such as corrosion inhibitor, descaler, and propylene glycol for freeze protection required for the water treatment program.
 - b. Provide sufficient propylene glycol to achieve the concentration by volume of total hydronic system capacities as specified or shown on the Drawings.
 - c. Conduct test analysis of the system water.
 - d. Furnish trained personnel to supervise initial fill and instruct designated Owner's personnel in maintaining proper concentration through water analysis and chemical dosage.
 - 2. The water treatment Contractor shall provide monthly visits to the facilities for the purpose of running tests on samples of treated water, reviewing the performance of the treatment program and making written recommendations

for any changes in chemical dosages that may be needed. Each visit shall be accompanied by a full written report describing the initial condition of the water and the recommended corrective action taken.

3.8 SCHEDULES

A. Piping:

1. All piping 2-1/2-inches and smaller run within the interior and exterior of a building shall be copper.
2. All piping 3-inches and larger run within the interior and exterior of a building shall be welded steel.
3. Use cast or wrought copper fittings for copper tube connections.
4. Use butt welded fittings for welded steel pipe connections.

B. Valves:

1. All valves for copper tubing shall be bronze bodied, unless specified otherwise.
2. All valves for steel piping shall be iron bodied, unless specified otherwise.
3. All valves 2-1/2-inches and smaller shall be of the soldered or threaded end type. Adaptors for threaded to solder connections shall be provided as required.
4. All valves 3-inches and larger shall be of the flanged end type.

++ END OF SECTION ++

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install hydronic pumps complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the hydronic pumps Work.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 05 33, Anchor Systems.
 - 3. Section 10 14 00, Signage.
 - 4. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
 - 5. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
 - 6. Section 23 09 00, Instrumentation and Control for HVAC.
 - 7. Section 26 05 05, General Provisions for Electrical Systems.
 - 8. Section 26 28 16.33, Disconnect Switches.

1.2 REFERENCES

- A. American Bearing Manufacturers Association (ABMA).
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
- B. American National Standards Institute (ANSI).
 - 1. ANSI/HI 1.3 – Rotodynamic (Centrifugal) Pumps Applications.
 - 2. ANSI/HI 9.6.4 – Rotodynamic Pumps for Vibration Measurement and Allowable Values.
 - 3. ANSI/HI 14.6 – Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
 - 4. ANSI B15.1 – Safety Standard for Mechanical Power Transmission Apparatus.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM A48 – Standard Specification for Gray Iron Castings.
 - 2. ASTM A159 – Standard Specification for Automotive Gray Iron Castings.

- D. Hydraulic Institute (HI).
- E. Institute of Electrical and Electronic Engineers (IEEE).
- F. National Electrical Code (NEC).
- G. National Electrical Manufacturers Association (NEMA).
- H. Occupational Safety and Health Administration (OSHA).
 - 1. OSHA 1910.219 – Mechanical Power-Transmission Apparatus.
- I. Underwriters Laboratories Inc. (UL).

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single hydronic pump manufacturer.
 - 2. Require the hydronic pump manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the hydronic pump manufacturer.
- C. Regulatory Requirements:
 - 1. National Electrical Code (NEC).
 - 2. National Fire Protection Association (NFPA).
 - 3. Underwriters Laboratories Inc. (UL).
 - 4. Local and State Building Codes and Ordinances.
 - 5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.
- D. Certifications:
 - 1. Hydronic pumps shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:

- a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - b. Setting drawings, templates, and directions for the installation of equipment pads, anchor bolts, and other anchorages.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Pump performance curves with operating points.
 - f. Standard and custom color selection charts for finishing system.
 - g. Requirements for Process Equipment.
 - h. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
 - i. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - j. Other technical data related to specified material and equipment as requested by Engineer.
 - 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Plan for performing required shop testing.
 - b. Plan for performing required field testing.
- B. Informational Submittals: Submit the following:
- 1. Certificates:
 - a. Certification of painting systems, in accordance with "Finishing" Article in this Section.
 - b. Independent certification reports:
 - 1) UL Label or equal.
 - 2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
 - 3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Motor shop test results in accordance with Section 40 05 93, Common Motor Requirements for Process Equipment.
 - c. Factory test reports.
 - 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
 - b. Results of motor tests at the Site in accordance with Section 40 05 93, Common Motor Requirements for Process Equipment.
 - 5. Supplier Reports:

- a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
 - 1. Maintenance Contracts:
 - a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
 - b. Service provided shall include the following:
 - 1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
 - a) Provide manufacturer's recommended maintenance.
 - b) Check all controls and components, and recalibrate or adjust as necessary.
 - c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - d) Review and provide recommendations concerning Owner's operations.
 - e) Replace or repair defective controls and components.
 - f) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - g) Provide a detailed field report to the Owner.
 - 2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
 - a) Telephone Technical Support.
 - b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

2. Operations and Maintenance Data:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
 3. Warranty Documentation:
 - a. General warranty.
 - b. Special warranties on materials and equipment.
- D. Maintenance Material Submittals: Furnish the following:
1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - b. One set of gaskets for each pump [type].
 - c. One shaft sleeve for each pump [type].
 - d. One set of seals for each pump type.
 2. Extra Stock Materials:
 - a. Touch up paint for each unit.
 3. Tools:
 - a. Two sets of special tools, if any, required for normal operation and maintenance.
 4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components

and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty on Materials and Equipment:
 - 1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or equipment specified in this Section found to be defective during a period of 1 year after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

- A. Design Criteria:
 - 1. Design conditions shall be as indicated on the Equipment Schedule.
 - 2. Maximum operating pressure: 175 psig.
 - 3. Maximum operating temperature: 225 degrees F.
 - 4. Pump bearings shall be rated for a minimum L-10 life of 60,000 hours at the pump's maximum operating speed in accordance with ABMA 9.
 - 5. Pumps shall be balanced in accordance with ANSI/HI 9.6.4, Grade G6.3.
 - 6. All materials of construction shall be suitable for use with 50 percent propylene glycol solution.
- B. Performance Criteria:
 - 1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.

2.2 DETAILS OF EQUIPMENT

- A. Circulator Pump:
 - 1. Equipment Description:
 - a. Factory assembled and tested base-mounted, single stage, end suction, bronze-fitted design with flexible-type coupler and horizontal shaft.
 - b. Pumps shall be back pull-out design allowing the pump to be serviced without disturbing the pump volute, piping connections, and motor assembly.

2. Product and Manufacturer: Provide one of the following:
 - a. Model UPS, as manufactured by Grundfos.
 - b. Or equal.
3. Construction:
 - a. Pump and motor form an integral unit without shaft seal and gaskets for sealing.
 - b. Ceramic shaft and radial bearing.
 - c. Carbon thrust bearing.
 - d. Stainless steel rotor can and bearing plate.
 - e. Corrosion resistant impeller.
 - f. Stainless steel pump housing.
4. Motor:
 - a. Squirrel-cage motor in conformity with EMC directive.
 - b. Incorporates thermal overload or impedance protection.

B. Pump Motors

1. Motors shall be premium efficiency, totally enclosed fan cooled (TEFC) type. Where TEFC motors are not available from the manufacturer, provide open drip proof (ODP) type with a letter from the manufacturer stating TEFC is not available.
2. Motors shall have a service factor of 1.15.
3. Motors shall be normal starting torque, normal slip, squirrel cage induction type. VFD driven motors shall be compatible for variable frequency drive operation and suitable to be applied in speed varying service without overheating.
4. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation imposed by the driven equipment.
5. Motors shall have Class F insulation with Class B temperature rise and be capable of carrying nameplate full load current plus service factor continuously without an injurious temperature rise in an ambient temperature of 40 degrees C.
6. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of operation imposed by the driven equipment.
7. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, ABMA, NEC, and ANSI.
8. Locked rotor currents shall be as specified in NEMA Standards.
9. Provide lubrication of non-hygroscopic grease.
10. Provide automatic breather and drain for TEFC motor enclosures.
11. Two speed motors shall be provided with two windings per phase.
12. Provide integral overload protection on all single phase motors.

2.3 ACCESSORIES

A. Disconnects:

1. Provide lockable, horsepower rated, unfused disconnects for all single phase motors conforming to Section 26 28 16.33, Disconnect Switches.
2. Disconnects shall be constructed and rated for the location in which they are installed. Refer to Section 26 05 05, General Provisions for Electrical Systems, and the Electrical Drawings for area classifications and ratings.

2.4 FINISHING

- A. Pumps shall be prepared and cleaned, and a high-grade machinery enamel coating systems applied and cured in strict accordance with the coating manufacturer's approved procedures. Primer coatings shall be selected for the specific material and application.
- B. Primer coat and finish coat dry film thickness shall be applied to the required thickness as recommended by the coating manufacturer to provide maximum corrosion protection.
- C. All gears, bearing surfaces, machined surfaces, and other surfaces that are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. Maintain coating during shipping and storage until equipment is placed into operation.

2.5 CONTROLS

- A. Refer to Section 23 09 00, Instrumentation and Control for HVAC, for sequence of operations.

2.6 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.
- B. Units shall be provided with nameplates giving the manufacturer's model and serial number, rated capacity, head, speed, and all other pertinent data. Nameplates shall be stainless steel with laser etched black letters. Nameplates shall be affixed to the units with two stainless steel self-tapping screws or rivets. Industrial grade adhesive that will not peel or lose adhesion strength due to extreme temperature variations with chemical and water resistances shall also be acceptable.

2.7 SOURCE QUALITY CONTROL

- A. Shop Tests:
 1. Pump Tests:
 - a. Except as described below or otherwise approved by Engineer, test one pump of each size in accordance with ANSI/HI 14.6. Tests are not required for standard pumps for which data on previously tested units of equal design is available. Curves and other test data from units

- previously tested shall be submitted with shop test results prior to shipping equipment.
- b. Test each pump for minimum three hours run-time, at the manufacturer's plant with the job or test motor. Vibration and temperature measurements shall be taken to determine its mechanical integrity. Vibration level shall be limited to the allowable values specified in ANSI/HI 9.6.4. Temperature of bearing housing near the end of run time shall not exceed 215 degrees F under artificially created ambient temperature of 104 degrees F.
 - c. Each test shall be witnessed by a registered professional engineer, who may be an employee of pump manufacturer. The professional engineer shall certify that the required tests were performed, and sign and seal the results. Jurisdiction of professional engineer's registration, registration number, and name shall be on the seal. Equipment serial number shall also appear on test data for the pump.
2. Motor Tests:
- a. Perform shop testing on and inspect each motor at motor manufacturer's factory in accordance with Section 40 05 93, Common Motor Requirements for Process Equipment.
3. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
- a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
 - c. Pump impellers and shafts shall be statically and hydraulically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:

1. Properly plug or cap the open ends of all piping connections at the end of each day's Work or other stopping point throughout the construction.
2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:

1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
4. Installation to conform to requirements of all local and state codes.

3.4 FIELD QUALITY CONTROL

A. Field Tests:

1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.
2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. Grease and lubricate all pumps as required.
 - c. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing. Equipment adjustment includes aligning the pump coupler using laser alignment for pumps over 20 HP and dial

indicate or straight edge align for 20 HP and below. Pump installation and alignment shall result in an unfiltered maximum peak to peak vibration displacement of 0.0038 inches for nominal 1800 RPM motors, 0.0022 inches for 3600 RPM, and 0.0058 for 1200 RPM. Note that all alignment including laser shall be completed in the field after installation, piping of the pump, and wiring of the motor. Alignment prior to shipment or installation in the field is not acceptable.

- d. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
- 2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
- 3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

- A. All pumps shall additionally be tested, adjusted, and balanced per Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.6 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 31 13

METAL DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install metal ductwork complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the metal ductwork Work.
- C. Related Sections:
 - 1. Section 10 14 00, Signage.
 - 2. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
 - 3. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
 - 4. Section 23 09 00, Instrumentation and Control for HVAC.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc. (AMCA).
 - 1. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.
 - 2. AMCA Publication 511 – Certified Ratings Program - Product Rating Manual for Air Control Devices.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
 - 1. ASHRAE Standard 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM E84 – Standard Test Method for Burning Characteristics of Building Materials.
 - 2. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 3. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- D. American Welding Society (AWS).
 - 1. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.
- E. National Bureau of Standard's Voluntary Product Standard.
 - 1. NBS PS 15-69 – Standard for Contact-Molded Reinforced Polyester Chemical Resistant Process Equipment.
- F. National Fire Protection Association (NFPA).
 - 1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 2. NFPA 90B – Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - 3. NFPA 701 – Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
- G. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
 - 1. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
 - 2. HVAC Duct Construction Standards – Metal and Flexible.
 - 3. Round Industrial Duct Construction Standards.
 - 4. Rectangular Industrial Duct Construction Standards.
- H. Underwriters Laboratories Inc. (UL).
 - 1. UL 181 – Factory-Made Air Ducts and Air Connectors.
 - 2. UL 181A – Closure Systems for Use With Rigid Air Ducts.
 - 3. UL 181B – Closure Systems for Use With Flexible Air Ducts and Air Connectors.
 - 4. UL 555 – Fire Dampers.
 - 5. UL 555S – Smoke Dampers.
 - 6. UL 900 – Air Filter Units.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
 - 2. Installer:
 - a. Engage an experienced installer to perform the work of this Section who has specialized in installing metal ductwork similar to that required for this Project and who is acceptable to manufacturer.
 - b. Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.

- 2) Approximate contract cost of the metal ductwork.
 - 3) Amount of area installed.
- 3. Welding:
 - a. Qualify processes and operators in accordance with AWS B2.1 as appropriate for material to be welded.
 - b. Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.
- B. Regulatory Requirements:
 - 1. National Electrical Code (NEC).
 - 2. National Fire Protection Association (NFPA).
 - 3. Underwriters Laboratories Inc. (UL).
 - 4. Local and State Building Codes and Ordinances.
 - 5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, and installation details.
 - b. 1/4-inch scale duct layouts, dimensioned to show length of runs, sizes, support spacing and expansion provisions.
 - c. Detailed installation drawing of each individual component showing:
 - 1) Mounting requirements.
 - 2) Locations.
 - d. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, wall thicknesses, design pressures, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - f. Other technical data related to specified material and equipment as requested by Engineer.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certification that all stainless steel ductwork, accessories, and hardware are of the Type specified.
 - 2. Manufacturer Instructions:

- a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
- 3. Source Quality Control Submittals:
 - a. Factory test reports.
- 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
- 5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
 - b. Installer, when requested by Engineer.
 - c. Welding, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
 - 1. Record Documentation:
 - a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the Work, submit "pdf" of CADD drawings showing the actual in place installation of all ductwork and equipment installed under this Section at a scale satisfactory to the Owner. The drawings shall show all ductwork on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 - 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 SITE CONDITIONS

A. Existing Conditions:

1. The Contract Documents show the general arrangement and extent of the Work to be done. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work is governed by the general building plans and the actual building conditions.
2. The Drawings are intended as an indication of the arrangement of equipment and ductwork and are as nearly correct as can be determined in advance of the actual construction of the Work. Equipment, ductwork, and appurtenances found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:

1. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of the systems, Contractor, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.
2. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case and adequately provide for expansion and minimize the amount of space required for the same.
3. The Drawings do not show all offsets, fittings, accessories and details, which may be required. Contractor shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others," to complete the systems to the true extent of the Contract Documents.

B. Design Criteria:

1. All sheet metal construction shall be in accordance with the construction details and installation details in the latest edition of the SMACNA HVAC Duct Construction Standards. This Standard is hereinafter referred to as HVAC DS.

2. Sheet metal construction shall conform to the following minimum pressure classification (positive and negative pressure), unless otherwise shown or specified:
 - a. Ductwork serving process spaces: 2-inch W.G.

2.2 DETAILS OF MATERIALS

- A. Material Type:
 1. Aluminum ductwork shall be Alloy 3003 – H-14 in accordance with ASTM B209.
 - a. All accessories for aluminum ductwork shall be aluminum, unless noted otherwise.
 2. Stainless steel ductwork shall be Type 316.
 - a. All accessories for stainless steel ductwork shall be Type 316 stainless steel, unless noted otherwise.
 - b. Welded stainless steel ductwork shall be Type 316L.
- B. Duct construction alternatives (duct gauge in relation to reinforcement spacing) selected by Contractor from HVAC DS Tables shall be identified by duct system and shall be submitted in schedule form to the Engineer prior to beginning installation of ductwork. Contractor shall construct ductwork to meet the requirements of the HVAC DS Tables in conjunction with the minimum duct thickness schedules in Article 3.10 below.
- C. Thickness of aluminum ductwork and size and thickness of aluminum supports shall be appropriately converted using the aluminum conversion tables in the HVAC DS.
- D. Rectangular ductwork longitudinal seams shall be Pittsburgh Lock type with permanently elastomeric sealant applied continuously within the seam.
- E. Round ductwork seams shall be spiral lock seam except for laboratory exhaust systems which shall be solid wall welded longitudinal seams.
- F. Duct reinforcement shall be made using external stiffener angles. Tie rods shall not be acceptable. Stiffener angles shall be constructed of the same material as the ductwork.
- G. Transverse Joints:
 1. Manufacturer: Provide product of one of the following:
 - a. Ductmate Industries, Inc.
 - b. Elgen Manufacturing Company, Inc.
 - c. Or equal.
 2. Ductwork shall be connected by a mechanical joining system, except where otherwise noted.
 3. Manufacturer's installation instructions will be followed, except where otherwise noted.

4. SMACNA T-24 and other flange type connectors formed from the duct edge will NOT be allowed.
5. All connectors shall meet or exceed the functional criteria outlined in the HVAC DS and shall be constructed of the same material as the ductwork.

H. Turning Vanes:

1. Manufacturer: Provide product of one of the following:
 - a. Ductmate Industries, Inc.
 - b. Elgen Manufacturing Company, Inc.
 - c. C.L. Ward & Family, Inc.
 - d. Or equal.
2. Material: Same material as ductwork.
3. Ducts 24-inches or shorter:
 - a. Vanes: Single thickness.
 - b. Runners: Type 2.
4. Ducts taller than 24-inches:
 - a. Vanes: Double thickness.
 - b. Runners: Type 1.

I. Splitter Dampers:

1. Reference: HVAC DS.
2. Material: Same material as ductwork.

J. Transitions and Offsets:

1. Reference: HVAC DS.
2. Material: Same material as ductwork.

K. Branch Take-Offs:

1. Reference: HVAC DS.
2. Material: Same material as ductwork.
3. 45 degrees, NO straight taps, unless specifically shown.

L. Rectangular Square Throat Elbows:

1. Reference: HVAC DS.
2. Material: Same material as ductwork.
3. Provided with turning vanes.

M. Rectangular Radius Elbows and Round Elbows:

1. Reference: HVAC DS.
2. Material: Same material as ductwork.
3. Centerline Radius: $R=1.5W$, unless specifically shown otherwise.

N. Round Converging Flow Fittings:

1. Converging flow fittings shall be constructed with a radius entrance to all branch taps and with no excess material projecting from the body into the branch tap entrance.
2. Branch entrances shall be by means of factory-fabricated fittings or factory fabricated duct tap assemblies.

- O. Seal Class:
 - 1. Class A – Ductwork constructed with a minimum pressure classification (positive and negative pressure) of 4-inch W.G. and up.
 - 2. Class B – Ductwork constructed with a minimum pressure classification (positive and negative pressure) less than 4-inch W.G.
- P. Leakage:
 - 1. Not to exceed five percent – All other systems.
- Q. Flexible duct or duct constructed of fiberglass duct board shall not be permitted, except where specifically shown or indicated.

2.3 ACCESSORIES

- A. Hangers and Supports:
 - 1. Hangers and supports shall be provided in accordance with Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
- B. Motorized Control Dampers and Volume Dampers (for Rectangular Ductwork):
 - 1. Commercial Type Dampers for Aluminum Ductwork:
 - a. Design and Performance Criteria (based on 48-inch damper width):
 - 1) Dampers shall be performance rated and certified in accordance with AMCA Standard 500-D and AMCA Publication 511.
 - 2) Maximum Design Total Static Pressure: 5.2-inch W.G.
 - 3) Damper Leakage: Class 1 Leakage Rated – Not more than 8 cfm per square foot at 4-inch W.G. with blade seals.
 - 4) Certification: Manufacturer shall submit certified test data.
 - b. Product and Manufacturer: Provide one of the following:
 - 1) Model CD50, as manufactured by Ruskin.
 - 2) Model VCD-40, as manufactured by Greenheck Fan Corporation.
 - 3) Or equal.
 - c. Details of Construction:
 - 1) Material: 6063-T5 aluminum.
 - 2) Frame: 0.125-inch thick hat channel with mounting flanges.
 - 3) Single Section Sizes:
 - a) Minimum: 6-inch wide by 9-inch high.
 - b) Maximum: 60-inch wide by 72-inch high.
 - 4) Blades:
 - a) 6-inch wide.
 - b) Opposed blades.
 - c) Airfoil shape with heavy gauge 6063-T5 aluminum double skin construction.
 - d) EPDM edge seals for motorized control dampers only.
 - 5) Linkage: Concealed in frame outside the air stream.
 - 6) Axles: 1/2-inch plated steel hex.
 - 7) Bearings: Molded synthetic.
 - 8) Jamb Seals: Flexible metal compressible type.

Provide Type 304 stainless steel outside handle, quadrant with 2-inch standoff and approved position indicator with locking device for all volume dampers.

C. Motorized Control Dampers and Volume Dampers (for Round Ductwork):

1. Commercial Type Dampers for Aluminum Ductwork:

- a. Design and Performance Criteria (based on 48-inch damper diameter):
 - 1) Dampers shall be performance rated and certified in accordance with AMCA Standard 500-D and AMCA Publication 511.
 - 2) Maximum Design Total Static Pressure: 4.0-inch W.G.
 - 3) Damper Leakage: Not more than 11.30 cfm total at 1-inch W.G. with blade seals.
 - 4) Certification: Manufacturer shall submit certified test data.
- b. Product and Manufacturer: Provide one of the following:
 - 1) Model CDRS82, as manufactured by Ruskin.
 - 2) Or equal.
- c. Details of Construction:
 - 1) Material: Same as ductwork.
 - 2) Frame: Minimum 16 gauge frame with 12 gauge mounting flanges.
 - 3) Single Section Sizes:
 - a) Minimum: 4-inch diameter.
 - b) Maximum: 48-inch diameter.
 - 4) Blades:
 - a) Minimum 16 gauge double skin construction with material same as ductwork.
 - b) EPDM continuous edge seals with pin angle stops for motorized control dampers only.
 - 5) Axles: Minimum 1/2-inch with material same as ductwork.
 - 6) Bearings: Stainless steel sleeve.
 - 7) Provide outside handle, quadrant with 2-inch standoff and approved position indicator with locking device constructed from same material as ductwork for all volume dampers.

2. Industrial Type Dampers for 316SS Ductwork:

- a. Design and Performance Criteria (based on 48-inch damper diameter):
 - 1) Dampers shall be performance rated and certified in accordance with AMCA Standard 500-D and AMCA Publication 511.
 - 2) Maximum Design Total Static Pressure: 15.0-inch W.G.
 - 3) Damper Leakage: Not more than 4.37 cfm total at 10-inch W.G. with blade seals.
 - 4) Certification: Manufacturer shall submit certified test data.
- b. Product and Manufacturer: Provide one of the following:
 - 1) Model CDRI92, as manufactured by Ruskin.
 - 2) Model HCDR-350, as manufactured by Greenheck Fan Corporation.
 - 3) Or equal.
- c. Details of Construction:
 - 1) Material: Same as ductwork.
 - 2) Frame: Minimum 10 gauge frame with 10 gauge mounting flanges.

- 3) Single Section Sizes:
 - a) Minimum: 4-inch diameter.
 - b) Maximum: 72-inch diameter.
- 4) Blades:
 - a) Minimum 10 gauge thick with material same as ductwork.
 - b) EPDM continuous edge seals with pin angle stops for motorized control dampers only.
- 5) Axles: Minimum 1/2-inch with material same as ductwork.
- 6) Bearings: Relubricable ball bearings mounted outboard of frame with shaft seals.
- 7) Provide outside handle, quadrant with 2-inch standoff and approved position indicator with locking device constructed from same material as ductwork for all volume dampers.

D. Gravity Backdraft Dampers (GBD):

1. Commercial Type GBD for Galvanized Steel and Aluminum Ductwork:
 - a. Provide gravity backdraft damper where specified on the Equipment Schedule or shown on the Drawings.
 - b. Design and Performance Criteria (based on 48-inch damper width):
 - 1) Dampers shall be performance rated and certified in accordance with AMCA Standard 500-D and AMCA Publication 511.
 - 2) Maximum Design Back Pressure: 4.0-inch W.G.
 - 3) Damper Leakage: Not more than 15 cfm per square foot at 1-inch W.G.
 - 4) Blades shall begin to open at approximately 0.12-inch W.G and shall be kept fully open at 0.20-inch W.G.
 - 5) Certification: Manufacturer shall submit certified test data.
 - c. Product and Manufacturer: Provide one of the following:
 - 1) Model BD6, as manufactured by Ruskin.
 - 2) Model EM, as manufactured by Greenheck Fan Corporation.
 - 3) Or equal.
 - d. Details of Construction:
 - 1) Material: 6063-T5 aluminum.
 - 2) Frame: Minimum 0.125-inch thick extruded aluminum frame.
 - 3) Single Section Sizes:
 - a) Minimum: 6-inch wide by 6-inch high.
 - b) Maximum: 48-inch wide by 52-inch high.
 - 4) Blades:
 - a) Extruded 0.070-inch thick 6063-T5 aluminum construction.
 - b) Extruded vinyl blade edge seals mechanically locked into extruded blade slots. Adhesive tape seals are not acceptable.
 - 5) Linkage: 1/2-inch tie bars with stainless steel pivot pins.
 - 6) Bearings: Molded synthetic.
 - 7) Provide a field-adjustable static pressure controller (SPC) to maintain static pressures in the ranges up to 0.25-inch W.G. for dampers up to 17.3 ft² and up to 0.75-inch W.G. for dampers up to 6 ft².

E. Access Doors:

1. Provide access doors for all fire and smoke dampers, control dampers, and other duct mounted devices where required to be accessible.
2. Access doors for fire and smoke dampers shall not affect the integrity of fire-resistance-rated assemblies. The access openings shall not reduce the fire-resistance rating of the assembly.
3. Access doors for fire and smoke dampers shall be labeled "FIRE/SMOKE DAMPER ACCESS", "SMOKE DAMPER ACCESS", or "FIRE DAMPER ACCESS" with minimum 1/2-inch high letters.
4. Reference: HVAC DS.
5. Material: Same as ductwork.
6. For Rectangular Ductwork:
 - a. Type: Gasketed cam lock covers.
 - b. Unless otherwise specified rectangular access doors shall be:
 - 1) 12 by X-2-inches for ducts X-inches and smaller less than 14-inches.
 - 2) 24 by 12-inches for ducts between 14 and 36-inches.
 - 3) 24 by 24-inches for ducts between 36 and 60-inches.
 - 4) Two 24 by 24-inch doors for ducts larger than 61-inches.
7. For Round Ductwork:
 - a. Type: Industrial oval gasketed access door with locking hand wheels.
 - b. Unless otherwise specified oval access door sizes shall be:

<u>Duct Diameter:</u>	<u>Nominal Opening:</u>
8 thru 18-inches:	10 by 6-inches.
19 thru 48-inches:	16 by 12-inches.
49 thru 72-inches:	24 by 18-inches.

F. Flexible Connectors (FC):

1. Design and Performance Criteria:
 - a. Flexible connectors shall be tested in accordance with UL 181.
 - b. Flexible connectors shall be listed and labeled as Class 0 or Class 1 flexible connectors.
 - c. Flexible connectors shall meet NFPA 90A, NFPA 90B, NFPA 701, and local building codes.
 - d. Maximum Design Total Static Pressure: 10.0-inch W.G.
 - e. Temperature Range: -65 degrees F to 500 degrees F.
 - f. Width: Minimum 4 inches, but shall not exceed 14 inches.
2. Product and Manufacturer: Provide one of the following:
 - a. Model Thermafab, as manufactured by Duro Dyne Corporation.
 - b. Model PROflex, as manufactured by Ductmate Industries, Inc.
 - c. Or equal.
3. Details of Construction:
 - a. Base Fabric: Woven fiberglass.
 - b. Coating: Silicone rubber.
 - c. Weight: 17 ounce per square yard.
 - d. Tensile Strength: 200 lb by 250 lb.
 - e. Tear Strength: 50 lb by 40 lb.
 - f. Features:

- 1) Excellent high temp resistance.
- 2) Excellent low temp resistance.
- 3) Excellent chemical resistance.
- 4) Excellent low smoke emission.
- 5) Excellent ozone resistance.
- 6) Excellent weathering.
- 7) Unaffected by mildew.
- g. Metal connectors shall be of the same material and gauge as ductwork with double-lock fold.

G. Miscellaneous Duct Fittings:

1. Reference: HVAC DS.
2. Material: Same material as ductwork.

H. Sleeves:

1. Material: Same material as ductwork passing through opening.
2. Thickness: Minimum 24-gauge.
3. Calk airtight with fire resistant sealant between sleeve and ductwork.

I. Duct Gaskets:

1. Product and Manufacturer: Provide one of the following:
 - a. Model 440 Gasket Tape, as manufactured by Ductmate Industries, Inc.
 - b. Model 440 Butyl Gasket, as manufactured by Elgen Manufacturing Company, Inc.
 - c. Or equal.
2. Material: Non-hardening butyl.
3. Service Temperatures: -30 degrees F to 180 degrees F.
4. Service Life: 20 years minimum.
5. Gaskets shall have the following Fire Hazard Classifications in accordance with ASTM E84:
 - a. Flame Spread: 10 maximum.
 - b. Smoke Developed: 10 maximum.

J. Hardware and Fasteners:

1. All hardware and fasteners for aluminum and stainless steel ductwork shall be Type 316 stainless steel, unless noted otherwise.

K. Grilles and Diffusers:

1. General:
 - a. Grilles and diffusers mounted in hung ceilings shall have a baked enamel white finish.
 - b. Aluminum grilles and diffusers not mounted in hung ceilings shall have an aluminum gray powder coat finish.
 - c. Stainless steel grilles and diffusers shall have a satin polish [mill] finish except where white polyvinylidene fluoride (PVDF) coating is specified on the Equipment Schedule.
 - d. Where registers are shown to be provided in lieu of grilles, include an integral opposed blade damper of the same construction as the grille.

2. Supply Grilles (SG):
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Aluminum construction:
 - a) Model X20, as manufactured by Anemostat.
 - b) Model A54, as manufactured by Tuttle & Bailey.
 - c) Model 300FL, as manufactured by Titus.
 - d) Or equal.
 - b. Double deflection with horizontal face bars for horizontal duct and vertical face bars for vertical duct.
 - c. 3/4-inch blade spacing.
 - d. For surface mounting as shown or indicated on Drawings.
 3. Return/Exhaust Grilles (RG/EG):
 - a. Product and Manufacturer: Provide one of the following:
 - 1) Aluminum construction:
 - a) Model X30, as manufactured by Anemostat.
 - b) Model A70, as manufactured by Tuttle & Bailey.
 - c) Model FL, as manufactured by Titus.
 - d) Or equal.
 - b. Single 0- or 45-degree deflection with horizontal face bars for horizontal duct and vertical face bars for vertical duct.
 - c. 3/4-inch blade spacing.
 - d. For surface mounting as shown or indicated on Drawings.

L. Wire Mesh Screens:

1. Wire mesh screens shall be provided where shown or specified on the Drawings and at exhaust gooseneck terminations.
2. Material:
 - a. Type 304 stainless steel mesh and frame for galvanized steel and aluminum ductwork.
 - b. Type 316 stainless steel mesh and frame for stainless steel ductwork.
3. Mesh Size: 3/4-inch by 3/4-inch interwoven with 0.135-inch (10 gauge) diameter wire.

2.4 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.5 SOURCE QUALITY CONTROL

- A. Shop Tests:
 1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.

- b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:
 - 1. Openings and penetrations shall be capped to protect the building from outside conditions.
 - 2. Properly cap the open ends of all ductwork at the end of each day's Work or other stopping point throughout the construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

- A. General:
 - 1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
 - 4. Installation to conform to requirements of all local and state codes.
- B. All ductwork shall conform accurately to the dimensions shown, the ducts shall be straight and smooth inside with joints neatly finished. Ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.
- C. Tape and seal all joints in accordance with HVAC DS. Tape shall not be used as the primary means of sealing. Tape used in sealing metallic ductwork shall be listed and labeled in accordance with UL 181A and shall be marked "181 A-P" for pressure-sensitive tape, "181 A-M" for mastic or "181 A-H" for heat-sensitive tape. Tape used in sealing flexible ductwork and connectors shall be listed and

labeled in accordance with UL 181B and shall be marked “181 B-FX” for pressure-sensitive tape or “181 B-M” for mastic.

- D. Fire dampers shall be provided and installed where indicated and where required by UL and authorities having jurisdiction, and shall be approved by local building codes and in accordance with the requirements of the NFPA.
- E. Install all ductwork and accessories to provide a system free from buckling, warping, bellowing, or vibration.
- F. All ducts at flexible connections with fans shall be supported at free end within 12-inches of flexible connection.
- G. Provisions shall be made for supporting all ductwork, dampers, and other ductwork accessories, where necessary.
- H. Coordinate all air outlets for compatibility with ceiling system.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer’s Services:
 - 1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
 - 2. Manufacturer’s service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer’s qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
 - 3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

- A. All duct systems shall be tested, adjusted, and balanced per Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
- B. Test openings shall be installed in the ductwork as directed by the testing, adjusting, and balancing Contractor. Test openings shall be sealed by a screw cap and gasket.

3.6 CLEANING

- A. Thoroughly clean all ductwork and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from ductwork and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.7 SCHEDULES

- A. Minimum Duct Thicknesses:
 - 1. One gauge thicker than recommended in the HVAC DS for the same pressure classification, reinforcement and support spacing.
- B. All ductwork and plenums serving the following equipment shall be aluminum:
 - 1. HV-1
 - 2. EF-1
 - 3. EF-2
 - 4. EF-3
 - 5. EF-4
 - 6. EF-5
 - 7. EF-7
- C. All ductwork and plenums serving the following equipment shall be 316 stainless steel:
 - 1. OCF-1.
 - 2. EF-6.
- D. Ductwork materials not specified above or on the Drawings shall be constructed of aluminum, unless otherwise directed by Engineer.

+ + END OF SECTION + +

SECTION 23 34 05

METALLIC HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install metallic HVAC fans complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the metallic HVAC fans Work.
- C. Related Sections:
 - 1. Section 10 14 00, Signage.
 - 2. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
 - 3. Section 23 09 00, Instrumentation and Control for HVAC.
 - 4. Section 26 05 05, General Provisions for Electrical Systems.
 - 5. Section 26 05 53, Identification For Electrical Systems.
 - 6. Section 26 28 16.33, Disconnect Switches.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc. (AMCA).
 - 1. AMCA Standard 99-0401 – Classification for Spark Resistant Construction.
 - 2. AMCA Standard 99-2408 – Operating Limits for Centrifugal Fans.
 - 3. AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.
 - 4. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - 5. AMCA Standard 300 – Reverberant Room Method for Sound Testing of Fans.
 - 6. AMCA Standard 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- B. American Bearing Manufacturers Association (ABMA).
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. Institute of Electrical and Electronic Engineers (IEEE).

- E. National Electrical Code (NEC).
- F. National Fire Protection Association (NFPA).
 - 1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 2. NFPA 91 – Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.
- G. Underwriters Laboratories Inc. (UL).
 - 1. UL 705 – Power Ventilators.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single metallic HVAC fan manufacturer.
 - 2. Require the metallic HVAC fan manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the metallic HVAC fan manufacturer.
- C. Regulatory Requirements:
 - 1. National Electrical Code (NEC).
 - 2. National Fire Protection Association (NFPA).
 - 3. Underwriters Laboratories Inc. (UL).
 - 4. Local and State Building Codes and Ordinances.
 - 5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.
- D. Certifications:
 - 1. Metallic HVAC fans shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
 - 2. Metallic HVAC fans shall be AMCA certified.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:

- a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
- b. Setting drawings, templates, and directions for the installation of roof/equipment curbs, anchor bolts, and other anchorages.
- 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Fan performance curves with operating points.
 - f. Standard and custom color selection charts for finishing system.
 - g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
 - h. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - i. Other technical data related to specified material and equipment as requested by Engineer.
- 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Plan for performing required shop testing.
 - b. Plan for performing required field testing.

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Certification of painting systems, in accordance with "Finishing" Article in this Section.
 - b. Independent certification reports:
 - 1) UL Label or equal.
 - 2) AMCA certification.
- 2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
- 3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
- 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
- 5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 6. Qualifications Statements:

- a. Manufacturer, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
- 1. Maintenance Contracts:
 - a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
 - b. Service provided shall include the following:
 - 1) Quarterly On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
 - a) Provide manufacturer's recommended maintenance.
 - b) Check all controls and components, and recalibrate or adjust as necessary.
 - c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - d) Review and provide recommendations concerning Owner's operations.
 - e) Replace or repair defective controls and components.
 - f) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - g) Provide a detailed field report to the Owner.
 - 2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
 - a) Telephone Technical Support.
 - b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.
 - 2. Operations and Maintenance Data:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

3. Warranty Documentation:
 - a. General warranty.
 - b. Special warranties on materials and equipment.
- D. Maintenance Material Submittals: Furnish the following:
 1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - b. One set of bearings for each belt drive fan.
 - c. One drive shaft for each belt drive fan.
 - d. One set of belts for each belt drive fan.
 2. Extra Stock Materials:
 - a. Touch up paint for each unit.
 3. Tools:
 - a. Two sets of special tools, if any, required for normal operation and maintenance.
 4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties

made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty on Materials and Equipment:

1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or equipment specified in this Section found to be defective during a period of 1 year after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Design Criteria:

1. Design conditions shall be as indicated on the Equipment Schedule.
2. Fans shall conform and be certified to UL 705.
3. Fan bearings shall be rated for a minimum L-10 life of 100,000 hours at the fan's maximum operating speed in accordance with ABMA 9 or 11.
4. Fans shall be balanced in accordance with AMCA Standard 204.
5. Spark resistant fan construction shall conform to AMCA Standard 99-0401.

B. Performance Criteria:

1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.
2. Fans shall be performance rated in accordance with AMCA Standards 210, 300, and 301.

2.2 details of equipment

A. Square Centrifugal Fans

1. Product and Manufacturer: Provide one of the following:
 - a. Model SQND, as manufactured by Loren Cook Company.
 - b. Or equal.
2. Housing:
 - a. Minimum 18-gauge continuously welded aluminum construction with integral air flow straightening vanes and 1-1/2 inch welded inlet and outlet flanges.
 - b. Factory insulated housing where specified on the Equipment Schedule.
 - c. Hinged inspection door shall be provided for access to the fan wheel.
 - d. Drive components shall be isolated for the airstream with a removable bearing cover and aerodynamic welded belt tunnel for belt drive units.
 - e. Mounting feet shall be provided to accommodate vertical or horizontal installation.
 - f. Type 304 stainless steel fasteners.
3. Fan Wheel:

- a. Centrifugal backward inclined, non-sparking aluminum construction with a machined cast aluminum hub.
- b. Hub shall be keyed and locked to the shaft with set screws or a taper lock bushing.
Inlet shall overlap a one piece aluminum hi-efficiency venturi.

B. Cast Aluminum Propeller Wall Fans

- 1. Product and Manufacturer: Provide one of the following:
 - a. Model AWD, as manufactured by Loren Cook Company.
 - b. Or equal.
- 2. Orifice Ring and Panel:
 - a. Minimum 14-gauge aluminum construction with continuously welded corners and hi-efficiency venturi.
 - b. Supply fans shall have an aluminum inlet.
 - c. Type 304 stainless steel fasteners.
- 3. Propeller:
 - a. Cast aluminum airfoil design with a cast aluminum hub.
 - b. Blade pitch shall be factory set and locked using set screws and roll pins.
Hub shall be keyed and locked to the shaft with set screws or a taper lock bushing.

C. Fan Motors

- 1. Motors shall be premium efficiency, totally enclosed fan cooled (TEFC) type. Where TEFC motors are not available from the manufacturer, provide open drip proof (ODP) type with a letter from the manufacturer stating TEFC is not available.
- 2. Motors shall have a service factor of 1.15.
- 3. Motors shall be normal starting torque, normal slip, squirrel cage induction type. VFD driven motors shall be compatible for variable frequency drive operation and suitable to be applied in speed varying service without overheating.
- 4. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation imposed by the driven equipment.
- 5. Motors shall have Class F insulation with Class B temperature rise and be capable of carrying nameplate full load current plus service factor continuously without an injurious temperature rise in an ambient temperature of 40 degrees C.
- 6. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of operation imposed by the driven equipment.
- 7. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, ABMA, NEC, and ANSI.
- 8. Locked rotor currents shall be as specified in NEMA Standards.
- 9. Provide lubrication of non-hygroscopic grease or oil type.
- 10. Provide automatic breather and drain for TEFC motor enclosures.
- 11. Two speed motors shall be provided with two windings per phase.
- 12. Provide integral overload protection on all single phase motors.

2.3 ACCESSORIES

- A. Variable Speed Controllers
 - 1. Where specified on the Equipment Schedule or shown on the Drawings.
- B. Gravity Backdraft Dampers (GBD)
 - 1. For roof mounted fans where specified on the Equipment Schedule or shown on the Drawings.
 - 2. End-pivoted, gravity backdraft damper constructed entirely of aluminum.
 - 3. Multiple, interlocked blades.
 - 4. Aluminum hinge pins.
 - 5. EPDM blade edges.
 - 6. Nylon bushings.
 - 7. Contractor shall furnish gravity backdraft dampers from the unit manufacturer.
- C. Shutters
 - 1. For all wall mounted propeller fans.
 - 2. End-pivoted, gravity backdraft damper constructed entirely of 6063-T6 aluminum.
 - 3. Multiple, link bar interlocked blades for uniform blade positioning.
 - 4. Aluminum hinge pins.
 - 5. Vinyl blade edges.
 - 6. Contractor shall furnish shutters from the unit manufacturer.
- D. Motor Guards
 - 1. For all wall mounted propeller fans.
 - 2. Painted 14 gauge steel frames with expanded metal screens.
 - 3. Removable rear panel for access to fan motor and drive.
 - 4. Contractor shall furnish shutters from the unit manufacturer.
- E. Prefabricated Roof Curbs
 - 1. Where specified on the Equipment Schedule or shown on the Drawings.
 - 2. Details of Construction:
 - a. Weatherproof, continuous welded, minimum 14-gauge (0.064-inch), aluminum construction with pressure treated wood nailer.
 - b. Insulated with minimum 1-1/2 inch thick, 3 lb/ft³ fiberglass sandwiched between inner and outer walls of curb.
 - c. 12 inches minimum height measured from top of finished roofing system to top of wood nailer. Contractor shall coordinate total height of curb with actual roofing system provided.
 - d. Provide wood blocking and wood cant as required.
 - e. Provide watertight flashing and counter flashing at curb.
 - f. Provide damper tray where backdraft damper is specified on the Equipment Schedule or shown on the Drawings.
 - 3. Curb Gasket: Minimum 1-inch wide by 1/2-inch thick EPDM gasket cemented to curb top to provide air and water seal between curb and housing. Neoprene is not acceptable.

4. Ventilator to Curb and Curb to Roof Deck Fasteners: Type 304 stainless steel hardware.
 5. Contractor shall furnish prefabricated roof curbs from the unit manufacturer.
- F. Companion Flanges
1. For all inline fans.
 2. Same material of construction as fan, predrilled to fit the flanges of the fan.
- G. Bird Screens
1. For all roof mounted and wall mounted fans.
 2. 3/4-inch by 3/4-inch, 0.135-wire diameter, aluminum mesh screen securely anchored to housing.
- H. Mounting Hardware
1. Provide Type 304 stainless steel hardware for all fan installation.
- I. Structural Supports
1. Contractor shall provide and install all hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances as required to mount equipment where shown. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall conform to Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

2.4 FINISHING

- A. All surfaces shall be prepared, and coating systems applied and cured in strict accordance with the coating manufacturer's approved procedures. Primer coatings shall be selected for the specific material and application.
- B. Primer coat and finish coat dry film thickness shall be applied to the required thickness as recommended by the coating manufacturer to provide maximum corrosion protection.
- C. The equipment manufacturer shall furnish a written affidavit that the equipment has been prepared, primed, and coated in strict accordance with the coating manufacturer's procedures and at the coating manufacturer's facility.
- D. All gears, bearing surfaces, machined surfaces, and other surfaces that are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. Maintain coating during shipping and storage until equipment is placed into operation.

2.5 CONTROLS

- A. Refer to Section 23 09 00, Instrumentation and Control for HVAC, for sequence of operations.

2.6 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.
- B. All electrical wiring identification shall be provided in accordance with Section 26 05 53, Identification For Electrical Systems.
- C. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per Owner standards.

2.7 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Fan Tests:
 - a. Except as described below or otherwise approved by Engineer, test one fan of each size in accordance with AMCA Standard 210. Tests are not required for standard fans for which data on previously tested units of equal design is available. Curves and other test data from units previously tested shall be submitted with shop test results prior to shipping equipment.
 - b. Test each fan for minimum three hours run-time, at the manufacturer's plant with the job or test motor. Vibration and temperature measurements shall be taken to determine its mechanical integrity. Vibration level shall be limited to a maximum of 1.25 mils. Temperature of bearing housing near the end of run time shall not exceed 215 degrees F under artificially created ambient temperature of 104 degrees F.
 - c. Each test shall be witnessed by a registered professional engineer, who may be an employee of fan manufacturer. The professional engineer shall certify that the required tests were performed, and sign and seal the results. Jurisdiction of professional engineer's registration, registration number, and name shall be on the seal. Equipment serial number shall also appear on test data for the fan.
 - 2. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
 - c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:
 - 1. Openings and penetrations shall be capped to protect the building from outside conditions.
 - 2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

- A. General:
 - 1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
 - 4. Installation to conform to requirements of all local and state codes.
 - 5. Curb mounted fans shall be provided with enough electrical wiring and conduit slack to allow the fan to be removed from the curb without disconnecting the electrical wiring at the fan.
- B. Anchorage shall be provided in accordance with Section 40 05 96, Vibration, Seismic, and Wind Controls.

3.4 FIELD QUALITY CONTROL

- A. Field Tests:
 - 1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.

2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

A. Adjust all controls for proper settings.

B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 34 06

NON-METALLIC HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install non-metallic HVAC fans complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the non-metallic HVAC fans Work.
- C. Related Sections:
 - 1. Section 10 14 00, Signage.
 - 2. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
 - 3. Section 23 09 00, Instrumentation and Control for HVAC.
 - 4. Section 26 05 05, General Provisions for Electrical Systems.
 - 5. Section 26 05 53, Identification For Electrical Systems.
 - 6. Section 26 28 16.33, Disconnect Switches.
 - 7. Section 40 05 93, Common Motor Requirements for Process Equipment.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc. (AMCA).
 - 1. AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.
 - 2. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - 3. AMCA Standard 300 – Reverberant Room Method for Sound Testing of Fans.
 - 4. AMCA Standard 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- B. American Bearing Manufacturers Association (ABMA).
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM E84 – Standard Test Method for Burning Characteristics of Building Materials.
 - 2. ASTM D4167 – Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.

- D. National Electrical Code (NEC).
- E. National Fire Protection Association (NFPA).
 - 1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 2. NFPA 91 – Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.
- F. Underwriters Laboratories Inc. (UL).

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single non-metallic HVAC fan manufacturer.
 - 2. Require the non-metallic HVAC fan manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the non-metallic HVAC fan manufacturer.
- C. Regulatory Requirements:
 - 1. National Electrical Code (NEC).
 - 2. National Fire Protection Association (NFPA).
 - 3. Underwriters Laboratories Inc. (UL).
 - 4. Local and State Building Codes and Ordinances.
 - 5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.
- D. Certifications:
 - 1. Non-metallic HVAC fans shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
 - 2. Non-metallic HVAC fans shall be AMCA certified.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.

- b. Setting drawings, templates, and directions for the installation of roof/equipment curbs, anchor bolts, and other anchorages.
- 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Fan performance curves with operating points.
 - f. Standard and custom color selection charts for finishing system.
 - g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
 - h. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - i. Other technical data related to specified material and equipment as requested by Engineer.
- 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Plan for performing required shop testing.
 - b. Plan for performing required field testing.

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Certification of painting systems, in accordance with "Finishing" Article in this Section.
 - b. Independent certification reports:
 - 1) UL Label or equal.
 - 2) AMCA certification.
- 2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
- 3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
- 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
- 5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.

C. Closeout Submittals: Submit the following:

1. Maintenance Contracts:

- a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
- b. Service provided shall include the following:
 - 1) Quarterly On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
 - a) Provide manufacturer's recommended maintenance.
 - b) Check all controls and components, and recalibrate or adjust as necessary.
 - c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - d) Review and provide recommendations concerning Owner's operations.
 - e) Replace or repair defective controls and components.
 - f) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - g) Provide a detailed field report to the Owner.
 - 2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
 - a) Telephone Technical Support.
 - b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

2. Operations and Maintenance Data:

- a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
- b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

3. Warranty Documentation:

- a. General warranty.

- b. Special warranties on materials and equipment.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - b. One set of bearings for each belt drive fan.
 - c. One drive shaft for each belt drive fan.
 - d. One set of belts for each belt drive fan.
 - 2. Extra Stock Materials:
 - a. Touch up paint for each unit.
 - 3. Tools:
 - a. Two sets of special tools, if any, required for normal operation and maintenance.
 - 4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 - 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor

under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special warranty on Materials and Equipment:

1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or equipment specified in this Section found to be defective during a period of 1 year after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Design Criteria:

1. Design conditions shall be as indicated on the Equipment Schedule.
2. Fan bearings shall be rated for a minimum L-10 life of 100,000 hours at the fan's maximum operating speed in accordance with ABMA 9 or 11.
3. Fans shall be balanced in accordance with AMCA Standard 204.
4. Fiberglass reinforced plastic fan construction shall conform to ASTM D4167.

B. Performance Criteria:

1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.
2. Fans shall be performance rated in accordance with AMCA Standards 210, 300, and 301.

2.2 details of equipment

A. FRP Pressure Blower:

1. Product and Manufacturer: Provide one of the following:
 - a. FPB, as manufactured by New York Blower Company.
 - b. Or equal.
2. General:
 - a. The fan shall be size 22 single-width single-inlet. The fan shall be constructed such that all surfaces in contact with the corrosive gas stream are to be made of corrosion resistant FRP. All nuts, bolts fasteners in contact with the gas stream shall be type 316 SS and encapsulated in FRP. Fan shall be AMCA arrangement 1. Wheel and shaft shall be dynamically balanced as an assembly in accordance with AMCA 204, Section 6.
3. Housing:
 - a. Constructed of a fire-retardant vinyl ester resin with ASTM E84 Class I rating. Housing laminate shall conform to ASTM Standard C-582. Air stream surface shall be smooth to minimize resistance and prevent build-up of airborne contaminants. Fans shall be furnished with flanged inlet and outlet.

4. Wheel:
 - a. Radial bladed designed for pressure development.
 - b. Wheel shall be cast from a solid resin-glass mixture and oven cured to provide optimum strength and corrosion resistance.
 - c. Resin used in wheel construction shall be a fire retardant vinyl ester with an ASTM E84 Class II rating no greater than 30.
 - d. Permanently bonded to the shaft.
5. Shaft:
 - a. Shaft shall be ASTM A-108 steel with an FRP sleeve fixed securely and bonded to the wheel backplate. Sleeve shall extend out through the housing shaft hole for corrosion protection.
6. Bearings:
 - a. Designed for a minimum L-10 life of 30,000 hours when rated at the fan's maximum cataloged operating speed.
 - b. Visible and accessible for inspection and maintenance.

B. FRP Upblast Tubeaxial:

1. Product and Manufacturer: Provide one of the following:
 - a. Series 37, as manufactured by Hartzell Fan Inc.
 - b. Or equal.
2. Housing:
 - a. All fiberglass reinforced plastic surfaces shall be constructed of Ashland Hetron 693 polyester resin with 3 percent antimony trioxide to achieve Class I flame spread rate below 25 or equivalent and glass fiber with integral inlet and outlet flanges.
 - b. All structural parts in the air stream shall be fiberglass and resin or epoxy coated Type 316 stainless steel.
 - c. Heavy duty fiberglass panel with lifting lugs for mounting onto roof curb.
 - d. All internal hardware (air stream) shall be encapsulated Type 316 stainless steel. Provide monel hardware where specified on the Equipment Schedule.
 - e. All external hardware (out of airstream) shall be Type 316 stainless steel.
 - f. All air stream surfaces shall be provided with a synthetic veil and electrostatically conductive surface coating.
3. Propeller:
 - a. Six airfoil blades.
 - b. Manufactured as a single piece, removed from the pattern whole using solid fiberglass die formed and coated with a corrosion resistant vinyl ester resin, Ashland Derakane 510-A or equivalent.
 - c. Totally encapsulated aluminum core insert for secure attachment to the shaft.
 - d. Provided with a synthetic veil and electrostatically conductive surface coating.
4. Shaft (Belt Drive Only):
 - a. Type 316 stainless steel, turned, ground, and polished. Provide monel shaft where specified on the Equipment Schedule.

- b. Machined and keyed at both ends with a fiberglass sleeve in the air stream.
 - c. Propeller shall be held tightly against the shaft shoulder by a Type 316 stainless steel bolt in the end of the shaft.
 - d. Type 316 stainless steel set screws shall be used to hold the key in place.
- 5. Shaft Seal (Belt Drive Only):
 - a. Fiberglass and neoprene shaft seal shall be located where the shaft leaves the bearing cover.
 - b. Neoprene shaft slinger shall be provided between the seal and propeller for belt drive fans.
- 6. Bearings (Belt Drive Only):
 - a. Heavy duty, self-aligning type with extended lube tubes for continuous service.
- 7. Stack Cap:
 - a. Fiberglass stack designed with enough height to effectively prevent wind resistance against operation of the fan.
 - b. Fiberglass butterfly damper shall be provided to open when fan is operating and to close when off to prevent entry of rain or snow.
- 8. Motor Base (Belt Drive Only):
 - a. Motor mounting plates shall be steel encapsulated with resin, mat, and cloth and mounted onto the housing exterior.
 - b. Fully adjustable platform style.

C. Fan Motors:

- 1. Motors shall be premium efficiency, totally enclosed fan cooled (TEFC) type. Where TEFC motors are not available from the manufacturer, provide open drip proof (ODP) type with a letter from the manufacturer stating TEFC is not available.
- 2. Motors shall have a service factor of 1.15.
- 3. Motors shall be normal starting torque, normal slip, squirrel cage induction type. VFD driven motors shall be compatible for variable frequency drive operation and suitable to be applied in speed varying service without overheating.
- 4. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation imposed by the driven equipment.
- 5. Motors shall have Class F insulation with Class B temperature rise and be capable of carrying nameplate full load current plus service factor continuously without an injurious temperature rise in an ambient temperature of 40 degrees C.
- 6. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of operation imposed by the driven equipment.
- 7. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, ABMA, NEC, and ANSI.
- 8. Locked rotor currents shall be as specified in NEMA Standards.
- 9. Provide lubrication of non-hygroscopic grease or oil type.
- 10. Provide automatic breather and drain for TEFC motor enclosures.

11. Two speed motors shall be provided with two windings per phase.
12. Provide integral overload protection on all single phase motors.
13. Provide severe duty type motors rated for chemical atmospheres where specified on the Equipment Schedule.
14. Provide motors rated for NFPA Class 1, Division 1 and/or Division 2 atmospheres where specified on the Equipment Schedule.

D. Belts and Drives:

1. Fans shall be belt drive with adjustable sheaves or direct drive as shown on the Equipment Schedule.
2. Belts shall be oil and heat resistant, non-static type.
3. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized with a minimum 1.5 service factor of the installed motor horsepower.

2.3 ACCESSORIES

A. Combination Motor Cover and Belt Guard:

1. For all fans with out-of-the-airstream mounted motors.
2. Epoxy coated steel construction with vents and tachometer hole.

B. Gravity Backdraft Dampers (GBD):

1. For roof mounted fans where specified on the Equipment Schedule or shown on the Drawings.
2. End-pivoted, gravity backdraft damper constructed entirely of fiberglass.
3. Maximum Temperature: 200 degrees F.
4. Maximum Face Velocity: 2,500 fpm.
5. Maximum Differential Pressure: 1.0-inch W.G.
6. Contractor shall furnish gravity backdraft dampers from the unit manufacturer.

C. Mounting Feet:

1. For all inline fans.
2. Epoxy coated steel construction bolted to the inlet and outlet flanges for mounting fan to floor, ceiling, wall, or platform.

D. Curb Panels and Stack Caps:

1. For roof mounted tubular centrifugal fans where specified on the Equipment Schedule or shown on the Drawings.
2. Heavy duty fiberglass panel with lifting lugs for mounting onto roof curb.
3. Fiberglass stack designed with enough height to effectively prevent wind resistance against operation of the fan.
4. Fiberglass butterfly damper shall be provided to open when fan is operating and to close when off to prevent entry of rain or snow.

E. Companion Flanges:

1. For all inline fans.
2. Fiberglass construction, predrilled to fit the flanges of the fan.

- F. Bird Screens:
 - 1. For all roof mounted and wall mounted fans.
 - 2. Provide 3/4-inch by 3/4-inch, 0.135-wire diameter, epoxy coated Type 316 stainless steel mesh screen securely anchored to housing.
- G. Mounting Hardware:
 - 1. Provide Type 316 stainless steel hardware for all fan installation.
- H. Structural Supports:
 - 1. Contractor shall provide and install all hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances as required to mount equipment where shown. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall conform to Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

2.4 FINISHING

- A. All fiberglass surfaces shall be protected with a minimum 10 mil dry film thickness of chemical, flame, and ultraviolet resistant resin.
- B. All gears, bearing surfaces, machined surfaces, and other surfaces that are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. Maintain coating during shipping and storage until equipment is placed into operation.

2.5 CONTROLS

- A. Refer to Section 23 09 00, Instrumentation and Control for HVAC, for sequence of operations.

2.6 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.
- B. All electrical wiring identification shall be provided in accordance with Section 26 05 53, Identification For Electrical Systems.
- C. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per Owner standards.

2.7 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Fan Tests:
 - a. Except as described below or otherwise approved by Engineer, test one fan of each size in accordance with AMCA Standard 210. Tests are not required for standard fans for which data on previously tested units of equal design is available. Curves and other test data from units

- previously tested shall be submitted with shop test results prior to shipping equipment.
- b. Test each fan for minimum three hours run-time, at the manufacturer's plant with the job or test motor. Vibration and temperature measurements shall be taken to determine its mechanical integrity. Vibration level shall be limited to a maximum of 1.25 mils. Temperature of bearing housing near the end of run time shall not exceed 215 degrees F under artificially created ambient temperature of 104 degrees F.
 - c. Each test shall be witnessed by a registered professional engineer, who may be an employee of fan manufacturer. The professional engineer shall certify that the required tests were performed, and sign and seal the results. Jurisdiction of professional engineer's registration, registration number, and name shall be on the seal. Equipment serial number shall also appear on test data for the fan.
2. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
- a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
 - c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:
 - 1. Openings and penetrations shall be capped to protect the building from outside conditions.
 - 2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:

1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
4. Installation to conform to requirements of all local and state codes.
5. Roof curb mounted fans shall be provided with enough electrical wiring and conduit slack to allow the fan to be removed from the curb without disconnecting the electrical wiring at the fan.

B. Anchorage shall be provided in accordance with Section 40 05 96, Vibration, Seismic, and Wind Controls.

3.4 FIELD QUALITY CONTROL

A. Field Tests:

1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.
2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.
3. Sound Tests:
 - a. Perform sound power level test as requested by the Engineer. Test results shall be rated in dBA.
 - b. Take the overall sound power level at the unit's inlet and outlet openings. Sound level shall not exceed approved sound level performance.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:

- a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

- A. Adjust all controls for proper settings.
- B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 52 16
CONDENSING BOILERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install condensing boilers complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the condensing boilers Work.
- C. Related Sections:
 - 1. Section 05 05 33, Anchor Systems.
 - 2. Section 10 14 00, Signage.
 - 3. Section 23 09 00, Instrumentation and Control for HVAC.
 - 4. Section 23 21 23, Hydronic Pumps
 - 5. Section 26 28 16.33, Disconnect Switches.

1.2 REFERENCES

- A. American National Standards Institute (ANSI).
 - 1. ANSI Z21.13 – Gas-Fired Low Pressure Steam and Hot Water Boilers.
- B. American Society of Mechanical Engineers (ASME).
 - 1. ASME Boiler and Pressure Vessel Code.
 - a. Section I – Rules for Construction of Power Boilers.
 - b. Section II – Materials.
 - c. Section IV – Rules for Construction of Heating Boilers.
 - d. Section V – Nondestructive Examination.
 - e. Section VI – Recommended Rules for the Care and Operation of Heating Boilers.
 - f. Section VII – Recommended Guidelines for the Care of Power Boilers.
 - g. Section VIII – Rules for Construction of Pressure Vessels.
 - h. Section IX – Welding and Brazing Qualifications.
 - i. Section X – Fiber-Reinforced Plastic Pressure Vessels.
 - 2. ASME CSD-1 – Controls and Safety Devices for Automatically Fired Boilers.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.

- D. Code of Federal Regulations (CFR).
 - 1. CFR Title 10, Part 431 – Energy Efficiency Program for Certain Commercial and Industrial Equipment.
- E. Institute of Boiler and Radiator Manufacturers (IBR).
- F. National Electrical Manufacturers Association (NEMA).
- G. National Fire Protection Association (NFPA).
 - 1. NFPA 54 – National Fuel Gas Code.
- H. Underwriters Laboratories Inc. (UL).
 - 1. UL 795 – Commercial-Industrial Gas Heating Equipment.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single condensing boiler manufacturer.
 - 2. Require the condensing boiler manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the condensing boiler manufacturer.
- C. Regulatory Requirements:
 - 1. Factory Mutual (FM).
 - 2. Industrial Risk Insurers (IRI).
 - 3. National Electrical Code (NEC).
 - 4. National Fire Protection Association (NFPA).
 - 5. Underwriters Laboratories Inc. (UL).
 - 6. Local and State Building Codes and Ordinances.
 - 7. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.
- D. Certifications:
 - 1. Condensing boilers shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - b. Detailed drawings of each individual component's wiring diagrams.
 - c. Detailed drawings of control panel layout.
 - d. Detailed installation drawing of each individual component showing:
 - 1) Mounting requirements.
 - 2) Locations (panel, field, etc.)
 - 3) Flue, burner, piping and wiring connections, labeled and coded.
 - e. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - f. Other technical data related to specified material and equipment as requested by Engineer.
- B. Informational Submittals: Submit the following:
1. Certificates:
 - a. Independent certification reports:
 - 1) UL Label or equal.
 2. Test and Evaluation Reports:
 - a. ASME Form P-2 – Manufacturer's Data Report for All Types of Boilers Except Watertube and Electric.
 - b. ASME Form U-1 Manufacturer's Data Report for Pressure Vessels.
 3. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
 4. Source Quality Control Submittals:
 - a. Factory test reports.
 5. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
 6. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and

results obtained. Submit within two days of completion of visit to the Site.

7. Qualifications Statements:

- a. Manufacturer, when requested by Engineer.

C. Closeout Submittals: Submit the following:

1. Maintenance Contracts:

- a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
- b. Service provided shall include the following:
 - 1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
 - a) Provide manufacturer's recommended maintenance.
 - b) Check all controls and components, and recalibrate or adjust as necessary.
 - c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - d) Review and provide recommendations concerning Owner's operations.
 - e) Replace or repair defective controls and components.
 - f) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - g) Provide a detailed field report to the Owner.
 - 2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
 - a) Telephone Technical Support.
 - b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

2. Operations and Maintenance Data:

- a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
- 3. Warranty Documentation:
 - a. General warranty.
 - b. Special warranties on materials and equipment.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - 2. Tools:
 - a. Two sets of special tools, if any, required for normal operation and maintenance.
 - 3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 - 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

- A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties

made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties on Materials and Equipment:

1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or equipment found to be defective during a period of 5 year after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:

1. The boiler shall be assembled, fire tested and shipped as a factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted & wired, with boiler connections specified in this Section.
2. The boiler shall be equipped with an integral pre-mix, metal-mesh type forced draft burner incorporating full modulation with 5:1 turndown.
3. The boiler gas valve will be designed with zero pressure regulation and equipped with a variable speed blower system to precisely control the fuel/air mixture, providing fully modulating firing rates for maximum efficiency.
4. The boiler shall be provided with a heavy duty 20 gauge steel jacket with a rust resistant powder coat finish. Jackets made of plastic or resin material shall not be acceptable.
5. A polypropylene condensate trap with a float-actuated shut-off switch shall be located within the boiler jacket and beneath the heat exchanger drain pan.

B. Design Criteria:

1. Design conditions shall be as indicated on the Equipment Schedule.
2. Units shall be designed such that the thermal efficiency increases as the unit firing rate decreases.
3. The boiler shall be constructed in conformance to ASME Section IV and ANSI Z21.13.
4. The boiler shall bear the ASME "H" stamp with a maximum allowable working pressure (MAWP) of 160 PSI. Pressure vessel shall be subjected to a hydrostatic pressure test of 240 PSIG at the factory before shipment.
5. Units shall be provided with controls and safety devices that meet ASME CSD-1 requirements.
6. Units with gas-fired burners shall conform and be certified to the latest edition of ANSI Z21.13 or UL 795.

C. Performance Criteria:

1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.

2. The burner shall emit no more than 20 ppm NO_x and 50 ppm CO (corrected to 3% O₂) at all firing rates.
3. Units shall meet or exceed the Thermal Efficiency (E_t) shown on the Equipment Schedule when tested in accordance to the latest edition of CFR Title 10, Part 431.
4. Units shall have IBR gross output at 100 percent firing rate as indicated on the Equipment Schedule.

2.2 MANUFACTURERS

- A. Product and Manufacturer: Provide one of the following:
1. Model ALP, as manufactured by U.S. Boilers.
 2. Or equal.

2.3 DETAILS OF CONSTRUCTION

- A. Enclosure:
1. Unit shall be designed such that the combustion air is drawn from inside of the boiler enclosure, allowing for decoupling of combustion air supply and preheating the combustion air for increased efficiency.
 2. Unit shall be capable of sealed combustion by drawing combustion air from the outdoors via a PVC duct connected between the unit and the outdoors.
 3. Enclosure shall be of insulated sheet metal construction and be fully removable allowing for access to boiler during servicing.
- B. Heat Exchanger:
1. Heat exchanger shall be of welded construction using ASME stainless steel.
 2. Minimum access opening shall not be less than 6-inch in diameter.
- C. Pressure Vessel:
1. Pressure vessel shall be of welded construction using ASTM A53/ASME SA53 stainless steel.
 2. Pressure vessel wall thickness shall not be less than 0.25-inch with minimum 0.50-inch thick upper head.
 3. Inspection openings in the pressure vessel shall be provided in accordance with ASME Boiler and Pressure Vessel Code, Section IV.
 4. Water connections shall be flanged type with a minimum ANSI rating of 150 pound.
- D. Boiler Trim:
1. Combination pressure-temperature gauge, 3-1/2 inch diameter.
 2. Provide UL listed, electric probe type low water cut-off and dual over-temperature protection including a manual reset mounted on boiler and wired into the burner control circuit to prevent burner operation if boiler water falls below allowable safe waterline.
 3. Supply and return temperature sensors - shall be mounted on the supply and return connections inside the boiler jacket. Each sensor shall be accessible through a removable access door on the side of the boiler. The boiler control

shall measure supply and return temperatures and notify the operator if the direction of flow is reversed.

- a. The boiler control shall adjust to impending temperature changes in such a way to minimize fuel consumption and maximize efficiency. The control shall measure temperatures and the rate of change in those temperatures and respond early, rather than waiting for temperatures to exceed limit control settings.
4. Provide additional UL listed, low water cut-off with manual reset as secondary low water control.
5. Outdoor air temperature sensor to automatically adjust the modulation rate setpoint on the boiler according to the outdoor temperature to optimize boiler operation and efficiency.
6. Flue gas temperature sensor shall be mounted in the flue vent connector to monitor flue gas temperatures and reduce the blower speed when flue gas temperatures exceed 184°F. If the flue temperatures exceed 194°F, a forced boiler recycle results.
7. Provide ASME certified pressure relief valve of the type and size to comply with ASME code requirements and set to relieve at 50 psig.
8. Water flow switch to prevent the burner operation during low water flow conditions.
9. Air vent valve shall be included to release trapped air inside the boiler's heat exchanger.
10. Drain valve, 3/4 inch.
11. Interconnecting wiring and conduit between system control components shall be the responsibility of Contractor.

E. Burner:

1. UL listed burner shall be designed and constructed as an integrated combustion system package and shall be factory fire tested.
2. Burner shall be suitable for use with natural gas with maximum and minimum inlet pressures of 13.5 inches W.C. and 4.5 inches W.C., respectively.
3. Combustion chamber shall be metal fiber mesh covering a stainless steel body with spark ignition and flame rectification.
4. All material exposed to the combustion zone shall be of stainless steel construction.
5. Burner shall be capable of a minimum of 5-to-1 turndown ratio of the firing rate without loss of combustion efficiency.
6. Gas Control Train:
 - a. Gas control train shall meet UL requirements and at minimum include the following:
 - 1) Manual shutoff cock by others.
 - 2) Main gas pressure regulator.
 - 3) Automatically operated main motorized gas valve with proof of closure interlock switch.
 - 4) Automatically operated auxiliary gas valve.
 - 5) Manual reset low and high gas pressure switches.
 - 6) Manual leak test cock.

- 7) Burner manifold gas pressure gauge and gauge cock.
 - 8) Automatically operated, normally open, vent valve.
 - b. In addition, gas control train shall meet Factory Mutual (FM) requirements and at minimum include the following:
 - 1) Leak test cock shall be UL listed.
 - 2) Automatically operated main motorized gas valve with proof of closure interlock switch shall carry a FM label.
- F. Exhaust & Intake Manifold:
- 1. The vent system shall be in accordance with National Fuel Code, NFPA 54/ANSI Z221.3.
 - 2. Exhaust and intake manifold shall be CPVC.
 - 3. Air intake piping shall be PVC that is sealed and pressure tight.
 - 4. Collecting reservoir with a gravity drain shall be provided for the elimination of condensation.

2.4 ACCESSORIES

- A. Unit shall be provided with a double acting type barometric damper for draft control. An electrical interlock shall be provided in the control panel which will shut off the fuel supply in the event that flue gases escape from the damper opening for a period of sixty seconds.
- B. Condensate Trap:
- 1. Provide a mechanical condensate trap on the condensate line capable of preventing flue gas from exiting through the condensate drain line.
- C. Condensate Neutralizer Kit:
- 1. Provide a neutralizer kit on the condensate line capable of neutralizing the acidic condensate.
 - 2. Kit shall be constructed from an acid resistant material filled with initial charge of neutralizing agent.
 - 3. Kit shall be sized to neutralize the maximum condensate produced by the boiler in full condensing mode.
- D. Indirect-Fired Water Heater:
- 1. Product and Manufacturer: Provide one of the following:
 - 2. Model AL70SL, as manufactured by U.S. Boilers:
 - a. Capacity: 70 gallons.
 - b. Construction:
 - 1) Heavy gauge steel tank.
 - 2) Top mount removable heat exchanger with double o-ring.
 - 3) Hydrastone lining.
 - 4) Polyurethane lining.
- E. Pump Control Panel (Switching Relay):
- 1. Product and Manufacturer: Provide one of the following:
 - a. Model SR506, as manufactured by Taco.

- b. Or equal.

2.5 FINISHING

- A. Unit enclosure and base frame shall have a powdered paint enamel coating that is capable of withstanding at least 250 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117 test procedure.

2.6 CONTROLS

- A. Unit shall be complete with the necessary controls, motor starters, overload protection, transformers with integral primary and secondary fuses, relays, contactors and terminal blocks for power and control wiring. Unit shall be provided with integral backlit LCD touchscreen display for diagnostic and troubleshooting information.
- B. Supply a Boiler Control System to provide safety interlocks and water temperature control. The control system shall be fully integrated into the boiler control cabinet and incorporate single boiler control logic, inputs, outputs and communication interfaces. The control system shall coordinate the operation of the modulating hot water boiler and circulation pumps. The control system shall control boiler modulation and on/off outputs based on the boiler water supply temperature and an operator-adjusted setpoint.
- C. Using PID (proportional-integral-derivative) based control, the remote system water temperature shall be compared with a setpoint to establish a target boiler firing rate. If the secondary loop flow speed is greater than the primary loop flow speed, firing rate is increased in response to the decrease in secondary loop temperature. When the remote system temperature is near the boiler high limit temperature, the boiler supply sensor shall limit the maximum boiler supply temperature to prevent boiler high limit events. Alternately, using parameter menu selections, the control system shall allow the boiler to respond directly to boiler supply temperature and setpoint to establish a target boiler firing rate while remote system water temperature is used for display purposes only. Each boiler's fuel flow control valve shall be mechanically linked to the air flow control device to assure an air rich fuel/air ratio. All the automated logic required to ensure that pre-purge, post-purge, light-off, and burner modulation shall be provided.
- D. When the controller is in the local control mode, the control system shall establish the setpoint based on outside air temperature and a reset function curve, or be manually adjusted by the operator. When enabled, the setpoint shall be adjusted above a preset minimum setpoint upon sensing a domestic hot water demand contact input. When in remote mode, the control system shall accept a Modbus or 4-20mA dc remote setpoint or firing rate demand signal from an external BAS.
- E. A touch screen message display shall be provided to display numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and

boiler historical information. In the event of a fault condition, the display shall provide help screens to determine the cause of the problem and corrective actions. Historical information shall include graphical trends, lockout history, boiler & circulator cycle counts and run time hours.

- F. The controller shall be capable of sequencing the boiler, domestic hot water or system circulators. Simple parameter selections shall allow all three pumps to respond properly to various hydronic piping arrangements including either a boiler or primary piped indirect water heater. The controller shall perform circulator exercise to help prevent pump rotor seizing.
- G. Unit shall be factory wired and tested. Prewired unit shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electrical Code. All electrical components shall bear the UL label.

A color-coded circuit diagram of the approved electrical drawing shall be provided with the unit. The circuit diagram shall include recommended power supply wire gauges and fuse sizes in conformance to the NEC. Typical wiring diagrams are not acceptable.

- H. Burner Flame Safeguard Controls:
Burner shall include flame safeguard controls utilizing spark ignition, rectification-type flame sensor for flame detection, and fully automatic sequencing of pre-purge, blower motor, ignition system, and fuel/air flow components.
- I. Refer to Section 23 09 00, Instrumentation and Control for HVAC, for additional information and sequence of operations.

2.7 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.
- B. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per Owner standards.

2.8 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Performance tested to meet IBR gross output at 100 percent firing rate.
 - c. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein

and that the package meets the specified performance requirements including manufacturer's data report.

- d. Hydrostatically pressure tested in accordance with ASME Boiler and Pressure Vessel Code, Section IV requirements.
- e. Boiler's burner shall be factory fire tested before shipment to assure proper function.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:
 - 1. Properly plug or cap the open ends of all flue, burner, and piping connections at the end of each day's Work or other stopping point throughout the construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

- A. General:
 - 1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
 - 4. Installation to conform to requirements of all local and state codes, including NFPA 54.
- B. Anchorages and Base Plates:
 - 1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.
 - 2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout

in accordance with Section 03 30 05, Concrete. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.4 FIELD QUALITY CONTROL

A. Field Tests:

1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly.
2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

- 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
- d. Technician shall revisit the Site as often as necessary until installation is acceptable.
- 3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

- A. Adjust all controls for proper settings.
- B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

SECTION 23 73 13

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to furnish and install modular indoor central-station air-handling units complete and operational with accessories.
 - 2. The Work shall comply with vibration, seismic, and wind control requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the modular indoor central-station air-handling units Work.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 05 33, Anchor Systems.
 - 3. Section 10 14 00, Signage.
 - 4. Section 23 09 00, Instrumentation and Control for HVAC.
 - 5. Section 26 05 53, Identification For Electrical Systems.
 - 6. Section 26 24 19, Motor Control Centers.
 - 7. Section 26 28 16.33, Disconnect Switches.
 - 8. Section 26 29 23, Low-Voltage Variable Frequency Drives.

1.2 REFERENCES

- A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
 - 1. AHRI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. Air Movement and Control Association International, Inc. (AMCA).
 - 1. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- C. American Bearing Manufacturers Association (ABMA).
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
- D. American National Standards Institute (ANSI).
 - 1. ANSI Z21.47 – Gas-Fired Central Furnaces.
 - 2. ANSI Z83.8 – Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-Fired Duct Furnaces.

- E. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
 - 1. ASHRAE Standard 15 – Safety Standard for Refrigeration Systems.
 - 2. ASHRAE Standard 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- F. American Society for Testing and Materials (ASTM).
 - 1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 2. ASTM D870 – Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.
 - 3. ASTM D1929 – Standard Test Method for Determining Ignition Temperature of Plastics.
 - 4. ASTM D2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
- G. National Electrical Code (NEC).
- H. National Electrical Manufacturers Association (NEMA).
 - 1. NEMA ICS 3.1 – Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers.
- I. Underwriters Laboratories Inc. (UL).
 - 1. UL 900 – Air Filter Units.
 - 2. UL 1995 – Heating and Cooling Equipment.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single modular indoor central-station air-handling unit manufacturer.
 - 2. Require the modular indoor central-station air-handling unit manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the modular indoor central-station air-handling unit manufacturer.
- C. Regulatory Requirements:
 - 1. Factory Mutual (FM).
 - 2. National Electrical Code (NEC).
 - 3. National Fire Protection Association (NFPA).

4. Underwriters Laboratories Inc. (UL).
5. Local and State Building Codes and Ordinances.
6. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

D. Certifications:

1. Modular indoor central-station air-handling units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - b. Detailed drawings of each individual component's wiring diagrams.
 - c. Detailed drawings of control panel layout.
 - d. Detailed installation drawing of each individual component showing:
 - 1) Mounting requirements.
 - 2) Locations (panel, field, etc.).
 - 3) Ductwork, piping, and wiring connections, labeled and coded.
 - e. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Fan performance curves with operating points.
 - f. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
 - h. Other technical data related to specified material and equipment as requested by Engineer.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Certification of unit painting systems in accordance with "Finishing" Article in this Section.
 - b. Independent certification reports:
 - 1) UL Label or equal.
 - 2) AHRI Label.
2. Manufacturer Instructions:

- a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
 - 3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
 - 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
 - b. Results of motor tests at the Site in accordance with Section 40 05 93, Common Motor Requirements for Process Equipment.
 - 5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 - 6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
- 1. Maintenance Contracts:
 - a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
 - b. Service provided shall include the following:
 - 1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
 - a) Provide manufacturer's recommended maintenance.
 - b) Check all controls and components, and recalibrate or adjust as necessary.
 - c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - d) Review and provide recommendations concerning Owner's operations.
 - e) Replace or repair defective controls and components.

- f) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - g) Provide a detailed field report to the Owner.
 - 2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
 - a) Telephone Technical Support.
 - b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.
 - 2. Operations and Maintenance Data:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
 - 3. Warranty Documentation:
 - a. General warranty.
 - b. Special warranties on materials and equipment.
- D. Maintenance Material Submittals: Furnish the following:
- 1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - b. One set of bearings for each fan.
 - c. One set of filters for each unit.
 - 2. Extra Stock Materials:
 - a. Touch up paint for each unit.
 - 3. Tools:
 - a. Two sets of fin combs for each fin spacing required.
 - 4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
 - 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties on Materials and Equipment:

1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or equipment specified in this Section found to be defective during a period of years as listed below after the date of Substantial Completion.
 - a. Heat exchanger shall carry a 10 year prorated warranty.
 - b. All coil coatings shall carry a 5 year non-prorated warranty.
 - c. All other components not listed above shall carry a minimum 1 year non-prorated warranty.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:

1. Units shall be completely factory assembled and tested, and internally piped and wired. Unit shall consist of insulated cabinet with filters, heating section, supply fans, motors and drives, mixing box, and including all unit mounted controls, wiring and accessories.
2. Units shall have a draw-through supply fan with horizontally or vertically discharge air configuration as shown on the Drawings.
3. Units shall be equipped with provisions for forklift or crane lifting and be designed structurally to withstand the stresses.
4. Factory fabricate and test units of sizes, capacities, and configuration as indicated and specified. Units shall be fully assembled on steel support members up to practical shipping limitations. On units not shipped fully assembled, manufacturer shall tag each section to indicate location and direction of airflow to facilitate assembly at the Site.

B. Design Criteria:

1. Design conditions shall be as indicated on the Equipment Schedule.
2. Units shall conform and be certified to the latest editions of ASHRAE Standard 15 and UL 1995.

C. Performance Criteria:

1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.

2.2 MANUFACTURERS

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

1. H3 Series, as manufactured by AAON.
2. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Cabinet:

1. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break with no metal path from inside to outside the cabinet.
2. All cabinet walls and access doors shall be insulated with closed cell polyurethane foam. Insulation shall have a minimum thermal resistances R-value of 6.25. Foam insulation shall have a minimum density of 2 lb/ft³ and shall be tested in accordance with ASTM D1929 for a minimum flash ignition temperature of 610 degrees F.
3. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Continuous sealing shall be included between panels and between access doors and openings. Refrigerant piping and electrical conduit through cabinet panels shall include sealing.
4. Unit construction shall allow for all maintenance on one side of the unit. Access to filters, dampers, cooling sections, heating sections, supply fans, and electrical and controls components shall be through flush mounted access doors with quarter turn, zinc cast, lockable handles. Removable stainless steel hinges shall be included on the doors. Removal of screwed wall panels shall not be acceptable.
5. Horizontal units shall include top-mounted threaded steel retainers to allow field installation of vertical hanger rods for hanging the units.
6. Unit shall provide an external location for mounting a disconnect device.

B. Hot Water Heating Section:

1. Coil shall be copper tubes with aluminum fins mechanically bonded to the tubes and 304 stainless steel end casings.
2. Coil shall be certified in accordance with AHRI Standard 410 and be leak tested to 200 psig and pressure tested to 450 psig at the factory.
3. Coil shall have labeled external piping connections. Sweat type liquid and suction connections shall extend beyond the unit casing and be factory sealed

with grommets that cover both the interior and exterior of the unit casing to minimize air leakage and condensation inside the panel assembly.

4. Coil shall be furnished with a field installed control valve.

C. Supply Fan:

1. Direct drive, backward curved, aluminum plenum fan shall be rated in accordance with AMCA Standard 210. Fan manufacturer shall be a member of AMCA. Fan shaft shall be ground and polished solid steel with pillow-block bearings.
2. Fan-motor assembly shall be provided with vibration isolators.

D. Fan Motors:

1. Motors shall be premium efficiency, totally enclosed fan cooled (TEFC) type. Where TEFC motors are not available from the manufacturer, provide open drip proof (ODP) type with a letter from the manufacturer stating TEFC is not available. High efficiency electrically commutated motor (ECM) shall be allowed as an alternative to TEFC motors.
2. Motors shall have a service factor of 1.15.
3. Motors shall be normal starting torque, normal slip, squirrel cage induction type. VFD driven motors shall be compatible for variable frequency drive operation and suitable to be applied in speed varying service without overheating.
4. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation imposed by the driven equipment.
5. Motors shall have Class F insulation with Class B temperature rise and be capable of carrying nameplate full load current plus service factor continuously without an injurious temperature rise in an ambient temperature of 40 degrees C.
6. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of operation imposed by the driven equipment.
7. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, ABMA, NEC, and ANSI.
8. Locked rotor currents shall be as specified in NEMA Standards.
9. Provide lubrication of non-hygroscopic grease or oil type.
10. Provide automatic breather and drain for TEFC motor enclosures.
11. Provide integral overload protection on all single phase motors.
12. Motor starter shall be provided where VFD is not specified on the Equipment Schedule. Refer to Section 26 24 19, Motor Control Centers, for requirements.

E. Filter Section:

1. Unit shall include a filter section of similar construction and finish as unit cabinet with filter guides or holding frames.
2. Section shall be fabricated to flange to other unit components.
3. Block-offs shall be provided as required to prevent air bypass around filters.

F. Filters:

1. Manufacturer: Provide product of one of the following:

- a. Camfil Farr Company.
 - b. Koch Filter Corporation.
 - c. American Air Filter.
 - d. Flanders Corporation.
 - e. Or equal.
- 2. Filter shall be of the throwaway pleated panel type.
 - 3. Filter media shall be a cotton and synthetic fiber blend lofted to a uniform depth and formed into a uniform radial pleat.
 - 4. A welded wire grid, spot-welded and treated for corrosion resistance shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation.
 - 5. A biodegradable enclosing frame of virgin-origin Kraft board, produced under an initiative for sustainable forest management, shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.
 - 6. Filter efficiency shall be determined in accordance with ASHRAE Standard 52.2 with a minimum MERV 8 rating.
 - 7. Filter shall be UL 900 Class 2 rated.
 - 8. Initial resistance to airflow shall not exceed 0.41-inch W.G. for a 2-inch deep or 0.35-inch W.G. for a 4-inch deep filter at a velocity of 500 fpm.

2.4 ACCESSORIES

- A. Unit shall include dirty filter switch for remote indication.

2.5 FINISHING

- A. Unit exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117 test procedure.
- B. Unit shall include interior corrosion protection which shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117 test procedure. Airstream surfaces, fans, and dampers shall all include the corrosion protection.
- C. Hydronic coils shall be coated uniformly without material bridging between fins with a flexible, epoxy polymer coating. Coating's humidity and water immersion resistances shall be up to a minimum of 1,000 and 250 hours when tested in accordance with ASTM D2247 and ASTM D870, respectively. Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the epoxy polymer coating.
- D. All gears, bearing surfaces, machined surfaces, and other surfaces that are to remain unpainted shall receive a heavy application of grease or other rust-resistant

coating. Maintain coating during shipping and storage until equipment is placed into operation.

2.6 CONTROLS

- A. Refer to Section 23 09 00, Instrumentation and Control for HVAC, for additional information and sequence of operations. Provide provisions for interfacing with the instrumentation and control (IC) system. Components requiring remote monitoring and control shall be wired to a terminal block for interfacing with the IC system. Contractor shall coordinate operating system requirements with Section 23 09 00, Instrumentation and Control for HVAC, for a complete system.
- B. Unit shall be completely factory wired with the necessary controls, starters, contactors and terminal blocks for power and control wiring.
- C. Unit shall be provided with phase and brown-out protection to de-energize all electrical components in the unit if the phases are more than 10 percent out of balance on voltage, or the voltage is more than 10 percent under design voltage, or on phase reversal.
- D. Control panel shall be of similar construction to unit conforming to UL 1995 and shall be provided with a hinged latching cover and multiple concentric knockouts for field wiring.
- E. Control panel shall be provided with automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside below the maximum and above the minimum operating temperature ratings of the electrical components.
- F. A color-coded circuit diagram of the approved electrical drawing shall be provided with the unit.
- G. All electrical components shall bear the UL label.
- H. Unit shall be designed for single point electrical connection. All necessary power transformers shall be factory provided and installed.
- I. Units with ECM driven supply fan shall have factory installed potentiometer within control panel to allow for adjustment of airflow setpoint.
- J. Factory Provided Unit Controller:
 - 1. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
 - 2. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - 3. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

4. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
5. Constant Volume Controller:
 - a. Outside air temperature sensor, supply air temperature sensor and space temperature sensor with temperature setpoint reset and unoccupied override shall be furnished with the unit for field installation.

2.7 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.
- B. All electrical wiring identification shall be provided in accordance with Section 26 05 53, Identification For Electrical Systems.
- C. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per Owner standards.

2.8 SOURCE QUALITY CONTROL

- A. Shop Tests:
 1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
 - c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:
 1. Openings and penetrations shall be capped to protect the building from outside conditions.

2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:

1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
4. Installation to conform to requirements of all local and state codes.

3.4 FIELD QUALITY CONTROL

A. Field Tests:

1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.
2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.

- b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

- A. Adjust all controls for proper settings.
- B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 81 26

DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to furnish and install ductless split-system air-conditioners complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the ductless split-system air-conditioners Work.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 05 33, Anchor Systems.
 - 3. Section 10 14 00, Signage.
 - 4. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
 - 5. Section 23 09 00, Instrumentation and Control for HVAC.
 - 6. Section 26 28 16.33, Disconnect Switches.

1.2 REFERENCES

- A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
 - 1. AHRI 210/240 – Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
 - 1. ASHRAE Standard 15 – Safety Standard for Refrigeration Systems.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 3. ASTM B280 – Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- D. National Electrical Code (NEC).
- E. National Electrical Manufacturers Association (NEMA).

- F. Underwriters Laboratories Inc. (UL).
 - 1. UL 1995 – Heating and Cooling Equipment.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single ductless split-system air-conditioner manufacturer.
 - 2. Require the ductless split-system air-conditioner manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the ductless split-system air-conditioner manufacturer.
- C. Regulatory Requirements:
 - 1. National Electrical Code (NEC).
 - 2. National Fire Protection Association (NFPA).
 - 3. Underwriters Laboratories Inc. (UL).
 - 4. Local and State Building Codes and Ordinances.
 - 5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.
- D. Certifications:
 - 1. Ductless split-system air-conditioners shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - b. Detailed drawings of each individual component's wiring diagrams.
 - c. Detailed drawings of control panel layout.
 - d. Detailed installation drawing of each individual component showing:
 - 1) Mounting requirements.
 - 2) Locations (panel, field, etc.).
 - 3) Ductwork, piping, and wiring connections, labeled and coded.
 - e. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.

2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Fan performance curves with operating points.
 - f. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
 - h. Other technical data related to specified material and equipment as requested by Engineer.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Certification of unit painting systems in accordance with "Finishing" Article in this Section.
 - b. Independent certification reports:
 - 1) UL Label or equal.
 - 2) AHRI Label.
2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.

C. Closeout Submittals: Submit the following:

1. Maintenance Contracts:
 - a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.

- b. Service provided shall include the following:
 - 1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the Owner and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the Owner at least one week in advance. The quarterly service shall include, but not limited to the following:
 - a) Provide manufacturer's recommended maintenance.
 - b) Check all controls and components, and recalibrate or adjust as necessary.
 - c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - d) Review and provide recommendations concerning Owner's operations.
 - e) Replace or repair defective controls and components.
 - f) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - g) Provide a detailed field report to the Owner.
 - 2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the Owner. Technical support shall include, but not limited to the following:
 - a) Telephone Technical Support.
 - b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.
 - 2. Operations and Maintenance Data:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
 - 3. Warranty Documentation:
 - a. General warranty.
 - b. Special warranties on materials and equipment.
- D. Maintenance Material Submittals: Furnish the following:
- 1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - b. One set of filters for each unit.

2. Tools:
 - a. Two sets of fin combs for each fin spacing required.
3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

- A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.
- B. Special Warranties on Materials and Equipment:
 1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or equipment specified in this Section found to be defective during a period of years as listed below after the date of Substantial Completion.
 - a. Compressors shall carry a minimum 6 year non-prorated warranty.
 - b. All other components not listed above shall carry a minimum 5 year non-prorated warranty.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

- A. Equipment Description:
 - 1. Units shall be completely factory assembled and tested, and internally piped and wired. Units shall consist of indoor air conditioners (indoor units) with filters, evaporator coils, supply fans, motors, and remotely located outdoor air-cooled condensing units (outdoor units).
 - 2. Units shall include all unit mounted controls, wiring, and accessories.
 - 3. Indoor units and refrigerant pipes shall be purged with dry air before shipment from the factory.
 - 4. Outdoor units shall be pre-charged with refrigerant for a minimum of 70 feet of refrigerant tubing.
- B. Design Criteria:
 - 1. Design conditions shall be as indicated on the Equipment Schedule.
 - 2. Units shall conform and be certified to the latest editions of ASHRAE Standard 15 and UL 1995.
- C. Performance Criteria:
 - 1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.
 - 2. Units shall meet or exceed the Energy Efficiency Ratio (EER) shown on the Equipment Schedule when tested in accordance to the latest editions of AHRI Standard 210/240.
 - 3. Outdoor units shall be capable of cooling operation down to 0 degree F ambient temperature without additional low ambient controls.
 - 4. Outdoor units configured as heat pumps shall be capable of heating operation down to 12 degree F ambient temperature.
 - 5. Outdoor units shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
 - 6. System shall be capable of operating up to a minimum refrigerant tubing length of 100 feet between indoor and outdoor units without the need for line size changes, traps or additional oil.

2.2 DETAILS OF EQUIPMENT

- A. Ceiling-Recessed Cassette Air Conditioners:
 - 1. Product and Manufacturer: Provide one of the following:
 - a. Model PLA, as manufactured by Mitsubishi Electric.
 - b. X Series, as manufactured by Sanyo.
 - c. Or equal.
 - 2. Cabinet:

- a. Cabinet shall be formed from galvanized sheet metal coated with high-density foam insulation.
 - b. Cabinet shall be for recessed mounting and provided with four corner mounting supports behind removable corner pockets in grille assembly allowing adjustment of mounting height from front of unit.
 - c. White grille assembly shall be attached to the front of the cabinet to provide supply air vanes in four directions and a center mounted return air section. Four-way grille shall allow two, three, or four-way blow.
 - d. Cabinet panel shall have provisions for a field installed filtered outside air intake.
 - e. Cabinet shall have a knock-out to provide a branch air duct for conditioning a secondary space.
3. Evaporator Coil:
- a. Coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy.
 - b. Coil shall be pressure tested at the factory.
 - c. Coil shall be furnished with a condensate pan and drain.
 - d. Unit shall include a built-in, automatic condensate lift mechanism that will be able to raise condensate 33 inches above the condensate pan. The lift mechanism shall be equipped with a positive acting liquid level sensor to shut down the indoor unit if liquid level in the drain pan reached maximum level.
4. Supply Fans:
- a. Direct drive, turbo propeller fan shall be driven by a single motor.
 - b. Multi-speed fan motor shall have permanently lubricated bearings.
 - c. Fan shall have a selectable AUTO fan setting that will adjust the fan speed based on the difference between controller setpoint and sensed space temperature.
5. Vanes:
- a. Motorized adjustable air outlet system shall provide two-way, three-way, or four-way airflow with switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
 - b. Vane angles shall be individually adjustable from the remote controller to customize the airflow pattern for the conditioned space.
 - c. Vanes shall have five fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
 - d. Vanes shall have the selectable capability to randomly cycle the vanes up and down to evenly heat the space in the heating mode.
6. Filter:
- a. Return air shall be filtered by means of an easily removable, washable polypropylene honeycomb filter.

B. Outdoor Units:

- 1. Product and Manufacturer: Provide one of the following:

- a. Model PUY, as manufactured by Mitsubishi Electric.
 - b. C Series, as manufactured by Sanyo.
 - c. Or equal.
- 2. Cabinet:
 - a. Casing shall be fabricated of galvanized steel.
 - b. Mounting feet shall be provided and shall be welded to the base of the cabinet.
 - c. Removable panel sections shall allow easy access to all serviceable parts.
 - d. Fan grill shall be constructed from ABS plastic.
 - e. Cabinet mounting and construction shall be sufficient to withstand 155 MPH wind speed conditions for use in Hurricane condition areas.
- 3. Condenser Fans:
 - a. Direct drive fan and motor shall be configured for horizontal discharge airflow.
 - b. Fan blades shall be of aerodynamic design for quiet operation and the fan motor bearings shall be permanently lubricated.
 - c. Fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.
 - d. Fan shall be provided with a raised guard to prevent external contact with moving parts.
- 4. Condenser Coil:
 - a. Coil shall be of copper tubing with flat aluminum fins.
 - b. Coil shall be protected with an integral metal guard.
- 5. Compressors:
 - a. Compressor shall be hermetically sealed, variable speed, rotary or scroll type. Compressor shall be equipped with an internal thermal overload.
 - b. Compressor shall be driven by inverter circuit to control compressor speed.
 - c. In lieu of a crankcase heater, minimal amount of current shall be automatically and intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant during the off cycle to prevent liquid accumulation.
 - d. Compressor shall be mounted so as to avoid transmission of vibration.
- 6. Refrigeration System:
 - a. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be control by a microprocessor controlled step motor.
 - b. System shall include an accumulator, high pressure safety switch, refrigerant line filter driers (strainers), Schrader type service fittings (stop valves) for liquid and suction connections, and service ports.

2.3 ACCESSORIES

A. Hangers and Supports:

- 1. Hangers and supports shall be provided in accordance with Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

- B. Refrigerant Piping and Insulation:
 - 1. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, Type ACR, meeting ASTM B280 requirements.
 - 2. Refrigerant piping shall be individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material.
 - 3. Insulation shall have a maximum thermal conductivity of 0.27 Btu-in/hr-ft²-degree F at 75 degrees F and a maximum water vapor transmission of 0.08 perm-in.
 - 4. Insulation shall have a maximum Flame Spread Index of 25 and a maximum Smoke Developed Index of 50 when tested in accordance with ASTM E84.
- C. Indoor units shall be provided with a condensate mini-pump that is capable of lifting condensate 23 inches above the drain pan.
- D. Outdoor units shall be provided with wind baffle for low ambient cooling operation.

2.4 FINISHING

- A. Outdoor units shall be finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Coating shall be capable of withstanding at least 500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117 test procedure.

2.5 CONTROLS

- A. Refer to Section 23 09 00, Instrumentation and Control for HVAC, for additional information and sequence of operations. Provide provisions for interfacing with the instrumentation and control (IC) system. Components requiring remote monitoring and control shall be wired to a terminal block for interfacing with the IC system. Contractor shall coordinate operating system requirements with Section 23 09 00, Instrumentation and Control for HVAC, for a complete system.
- B. Unit shall be completely factory wired with the necessary controls, starters, contactors and terminal blocks for power and control wiring.
- C. A color-coded circuit diagram of the approved electrical drawing shall be provided with the unit.
- D. All electrical components shall bear the UL label.
- E. Unit shall be designed for single point electrical connection. All necessary power transformers shall be factory provided and installed.
- F. The system shall be capable of satisfactory operation within voltage limits of 198 VAC to 253 VAC, 1 Phase, 60 Hz.

- G. The power to the indoor unit shall be supplied from the outdoor unit. A factory provided three AWG-14 wire conductors with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. The outdoor unit shall have Pulse Amplitude Modulation circuit to utilize 98 percent of input power supply.
- H. The control system shall consist of a minimum of two microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The outdoor unit shall be controlled by the microprocessor located in the indoor unit using 24 VDC pulse control signal.
- I. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation and controlling the outdoor unit.
- J. The system shall include a 3-minute time delay mechanism, an automatic restart function when power is restored after power interruption, and a test run switch.
- K. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the controller panel.
- L. Remote Controllers:
 - 1. Wired, Wall Mounted:
 - a. Remote controller shall be approximately 5-inch by 5-inch in size and white in color with a light-green LCD display.
 - b. The control voltage from the wired controller to the indoor unit shall be 12/24 VDC.
 - c. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. Up to two wired controllers shall be able to be used to control one unit.
 - d. Controller shall support a selection from multiple languages (Spanish, German, Japanese, Chinese, English, Russian, Italian, or French) for display information.
 - e. Controller shall include be a built-in weekly timer with up to 8 pattern settings per day.
 - f. Controller shall consist of an ON/OFF button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer ON/OFF button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button.
 - g. Controller shall have a built-in temperature sensor.
 - h. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C), and temperature changes shall be by increments of 1 degree F (0.5 degree C).
 - i. Controller shall have the capability of controlling up to a maximum of 16 systems, as a group with the same mode and temperature setpoint for all, at a maximum developed control cable distance of 1,500 feet.

- j. Basic functions of the controller shall include:
 - 1) ON/OFF for run and stop operation.
 - 2) Operation mode for switching between Cool/Dry/Auto/Fan/Heat.
 - 3) Temperature setpoints:
 - a) Cool/Dry: 67-87 degrees F.
 - b) Heat: 63-83 degrees F.
 - c) Auto: 67-83 degrees F.
 - 4) Fan speed settings.
 - 5) Air flow direction settings.
 - 6) Scheduling.
 - 7) Operating conditions and error code display.
 - 8) Ventilation control.
 - 9) Auto lock out function for setting or releasing of all buttons.

2.6 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.7 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
 - c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:

1. Openings and penetrations shall be capped to protect the building from outside conditions.
2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:

1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
4. Installation to conform to requirements of all local and state codes.

B. Anchorage shall be provided in accordance with Section 40 05 96, Vibration, Seismic, and Wind Controls.

C. Concrete Pad Anchorages and Base Plates:

1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.
2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.4 FIELD QUALITY CONTROL

A. Field Tests:

1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.
2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that

all controls work as intended in both manual and automatic mode.

Successfully test-operate each equipment for at least 24 hours.

- c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

- A. Adjust all controls for proper settings.
- B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

++ END OF SECTION ++

SECTION 23 82 39.16

HOT WATER UNIT HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install propeller unit heaters complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the propeller unit heaters Work.
- C. Related Sections:
 - 1. Section 10 14 00, Signage.
 - 2. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

1.2 REFERENCES

- A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
 - 1. AHRI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. Air Movement and Control Association International, Inc. (AMCA).
 - 1. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- C. American Society for Testing and Materials (ASTM).
 - 1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. National Electrical Code (NEC).
- E. National Electrical Manufacturers Association (NEMA).
- F. Underwriters Laboratories Inc. (UL).
 - 1. UL 873 – Temperature-Indicating and -Regulating Equipment.
 - 2. UL 1995 – Heating and Cooling Equipment.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:

- a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single propeller unit heater manufacturer.
 - 2. Require the propeller unit heater manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the propeller unit heater manufacturer.
- C. Regulatory Requirements:
 - 1. Factory Mutual (FM).
 - 2. National Electrical Code (NEC).
 - 3. National Fire Protection Association (NFPA).
 - 4. Underwriters Laboratories Inc. (UL).
 - 5. Local and State Building Codes and Ordinances.
 - 6. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.
- D. Certifications:
 - 1. Propeller unit heaters shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Standard and custom color selection charts for finishing system.
 - f. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - g. Other technical data related to specified material and equipment as requested by Engineer.

- B. Informational Submittals: Submit the following:
1. Certificates:
 - a. Independent certification reports:
 - 1) UL Label or equal.
 2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
 3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
 5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 2. Tools:
 - a. Two sets of fin combs for each fin spacing required.
 - b. Two sets of special tools, if any, required for normal operation and maintenance.
 3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.

2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
- C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

- A. Design Criteria:
1. Design conditions shall be as indicated on the Equipment Schedule.
 2. Units shall conform and be certified to UL 1995.
- B. Performance Criteria:
1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.

2.2 DETAILS OF EQUIPMENT

- A. Horizontal Unit Heaters:
1. Product and Manufacturer: Provide one of the following:
 - a. Model H, as manufactured by SIGMA Corporation.
 - b. Or equal.
 2. Casing:
 - a. Minimum 18-gauge corrosion-resistant steel construction.
 - b. Provided with mounting brackets and pre-punched holes for suspension mounting.
 3. Coils:
 - a. Coil shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 - b. Coil headers shall be of the same material of construction as tubes.

- c. Coil shall be certified in accordance with AHRI Standard 410 and be leak tested to 200 psig and pressure tested to 300 psig at the factory.
 - d. Coil shall have labeled external piping connections.
- 4. Fans:
 - a. Aluminum broad blade, axial-flow type design.
 - b. OSHA fan guard.
- 5. Fan Motors:
 - a. Totally-enclosed-fan-cooled [Explosion-proof-fan-cooled] enclosure.
 - b. NEMA rated and UL listed.
 - c. Permanently lubricated bearings.
 - d. Integral thermal cutout with automatic reset.
 - e. Attached with rubber vibration isolators.
- 6. Louvers:
 - a. Same material of construction as casing.
 - b. Individually adjustable for downward, upward or straight air flow.
- 7. Controls:
 - a. Integral electrical junction box pre-wired in liquid-tight conduit to fan motor.
 - b. Integral 120VAC control transfor.
 - c. Refer to Article 2.3 for thermostat control voltage.

B. Cabinet (Forced Flow) Unit Heaters:

- 1. Product and Manufacturer: Provide one of the following:
 - a. Model SFF Series, as manufactured by SIGMA Corporation.
 - b. Or equal.
- 2. Casing:
 - a. Minimum 16-gauge corrosion-resistant steel construction.
 - b. Removable front panel for access to motor, fans, controls and coil of the unit.
 - c. Hinged access door on front panel.
 - d. Recessing collars for units mounted flush in ceilings.
- 3. Coils:
 - a. Coil shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 - b. Coil headers shall be of the same material of construction as tubes.
 - c. Coil shall be certified in accordance with AHRI Standard 410 and be leak tested to 200 psig and pressure tested to 300 psig at the factory.
 - d. Coil shall have labeled external piping connections.
- 4. Blower:
 - a. Double-inlet double-width forward curved centrifugal type manufactured of corrosion resistant steel.
- 5. Fan Motors:
 - a. PSC type with self-aligning sleeve bearings.
 - b. Integral thermal cutout with automatic reset.

C. Convector Unit Heaters:

1. Product and Manufacturer: Provide one of the following:
 - a. Model CWS Series, as manufactured by SIGMA Corporation.
 - b. Or equal.
2. Casing:
 - a. Minimum 18-gauge corrosion-resistant steel construction.
 - b. Removable front panel for access to motor, fans, controls and coil of the unit.
3. Coils:
 - a. Coil shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 - b. Coil headers shall be of the same material of construction as tubes.
 - c. Coil shall be certified in accordance with AHRI Standard 410 and be leak tested to 200 psig and pressure tested to 300 psig at the factory.
 - d. Coil shall have labeled external piping connections.
4. Damper:
 - a. Damper for control of heating output from the convector.

2.3 ACCESSORIES

A. Space Thermostats (Non-Corrosive and Corrosive Environments)

1. Product and Manufacturer: Provide one of the following:
 - a. Model TW255A, as manufactured by TPI Corporation.
 - b. Model WCRT-100, as manufactured by Chromalox.
 - c. Or equal.
2. Sealed Noryl case.
3. Shielded nickel-plated sensing bulb attached directly to thermostat enclosure.
4. Thermostat Setpoint Range: 40 degrees F to 100 degrees F, with 2.5-degree F differential.
5. Adjustable setpoints through dial on face.
6. 120 VAC, 125 VA rating.
7. Contacts shall have proper ampere rating for intended use.
8. NEMA 4X rated.

B. Structural Supports

1. Contractor shall provide and install all hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances as required to mount all propeller unit heaters.
2. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall conform to Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

2.4 FINISHING

A. Manufacturer's standard finish.

2.5 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.6 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
 - c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 INSTALLATION

- A. General:
 - 1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
 - 4. Installation to conform to requirements of all local and state codes.

3.3 FIELD QUALITY CONTROL

- A. Field Tests:

1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and temperature levels do not exceed maximum limits.
2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that temperature limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.

3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 ADJUSTING

- A. Adjust all controls for proper settings.
- B. While system is operable, balance all equipment to achieve design conditions.
- C. Position unit as shown on the Drawings and adjust outlet louvers and diffusers for maximum throw.

3.5 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 23 82 39.43

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install electric unit heaters complete and operational with accessories.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the electric unit heaters Work.
- C. Related Sections:
 - 1. Section 10 14 00, Signage.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc. (AMCA).
 - 1. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- B. Factory Mutual (FM).
- C. National Electrical Code (NEC).
- D. National Electrical Manufacturers Association (NEMA).
- E. Underwriters Laboratories Inc. (UL).
 - 1. UL 873 – Temperature-Indicating and -Regulating Equipment.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single electric unit heater manufacturer.

2. Require the electric unit heater manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the electric unit heater manufacturer.

C. Regulatory Requirements:

1. Factory Mutual (FM).
2. National Electrical Code (NEC).
3. National Fire Protection Association (NFPA).
4. Underwriters Laboratories Inc. (UL).
5. Local and State Building Codes and Ordinances.
6. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

D. Certifications:

1. Electric unit heaters shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. Contractor shall be responsible for any additional expenses that may occur due to any exception made.
 - f. Other technical data related to specified material and equipment as requested by Engineer.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Independent certification reports:
 - 1) UL Label or equal.
2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.

- c. Instructions for handling, start-up, and troubleshooting.
- 3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
- 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
- 5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts:
 - a. Spare parts list and recommended quantities.
 - 2. Tools:
 - a. Two sets of special tools, if any, required for normal operation and maintenance.
 - 3. Spare parts and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
 - 3. Comply with manufacturer's recommendations for rigging of equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Design Criteria:

1. Design conditions shall be as indicated on the Equipment Schedule.
2. All electric unit heaters shall be UL Listed.

B. Performance Criteria:

1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.

2.2 DETAILS OF EQUIPMENT

A. Horizontal Unit Heaters (Non-Corrosive Environment):

1. Product and Manufacturer: Provide one of the following:
 - a. Model LUH, as manufactured by Chromalox.
 - b. Model Industrial Unit Heater, as manufactured by INDEECO.
 - c. Or equal.
2. Casing:
 - a. Minimum 18-gauge die formed steel construction.
 - b. Phosphate undercoated and finished with polyester powder coat.
 - c. Provided with universal wall swivel bracket and mounting hardware.
3. Heating Elements:
 - a. Corrosion resistant steel fins brazed to tubular element.
4. Fans:
 - a. Aluminum broad blade, axial-flow type design.
 - b. Attached with rubber vibration isolators.
5. Fan Motors:
 - a. Totally-enclosed-fan-cooled enclosure.
 - b. Permanently lubricated bearings.
 - c. Integral thermal cutout.
6. Louvers:
 - a. Same material of construction as casing.
 - b. Individually adjustable for downward, upward or straight air flow.
7. Controls:
 - a. Sub-divided circuits with individual fuse protection for all heaters with a total current draw of 48 A or greater.
 - b. Heavy duty magnetic contactors.

- c. Thermal cutout with automatic reset.
- d. Integral 120 VAC control transformer.
- e. Thermostats:
 - 1) Remote Type (shipped loose):
 - a) Refer to Article 2.3.

B. Explosion-Proof Horizontal Unit Heaters (Corrosive Environment):

- 1. Product and Manufacturer: Provide one of the following:
 - a. Model ULTRA-SAFE EXP, as manufactured by INDEECO.
 - b. Or equal.
- 2. Heaters shall be constructed in accordance with NEC requirements and be FM approved for NEC Class I and Class II, Division 1 and 2 hazardous atmospheres with a NEC temperature code T3C (320 degrees F ignition temperature).
- 3. Casing:
 - a. Minimum 14-gauge Type 316 stainless steel construction.
 - b. Provided with Type 316 stainless steel universal wall swivel bracket and mounting hardware.
- 4. Heating Exchangers:
 - a. Liquid-to-air design utilizing Type 316 stainless steel tubes with spiral wound aluminum fins.
 - b. Nontoxic, inhibited, propylene glycol heat transfer liquid that provides freeze protection down to -49 degrees F.
 - c. Pressure relief valve set at 70 psig.
 - d. Heating elements shall be of industrial grade.
- 5. Fans:
 - a. Heresite coated Aluminum broad blade, axial-flow type design.
 - b. Attached with rubber vibration isolators.
- 6. Fan Motors:
 - a. Explosion-proof-fan-cooled epoxy coated enclosure.
 - b. Permanently lubricated bearings.
 - c. Integral thermal cutout.
- 7. Louvers:
 - a. Same material of construction as casing.
 - b. Individually adjustable for downward, upward or straight air flow.
- 8. Controls:
 - a. NEMA 7 cast aluminum epoxy coated control enclosure.
 - b. Heavy duty magnetic contactors.
 - c. Automatic and manual reset overtemperature thermal cutouts.
 - d. Integral 120 VAC control transformer.
 - e. "Heater On" indication light.
 - f. "Warning" indication light.
 - g. Thermostats:
 - 1) Refer to Equipment Schedule for type.
 - 2) Integral Type (factory installed):
 - a) Thermostat Setpoint Range: 40 degrees F – 90 degrees F.

- b) Adjustable knob.
- 3) Remote Type (shipped loose):
 - a) Refer to Article 2.3.

2.3 ACCESSORIES

- A. Space Thermostats (Non-Corrosive and Corrosive Environments)
 - 1. Product and Manufacturer: Provide one of the following:
 - a. Model WCRT-100, as manufactured by Chromalox.
 - b. Model TW255A, as manufactured by TPI Corporation.
 - c. Or equal.
 - 2. Sealed Noryl case.
 - 3. Shielded nickel-plated sensing bulb attached directly to thermostat enclosure.
 - 4. Thermostat Setpoint Range: 40 degrees F to 100 degrees F, with 2.5-degree F differential.
 - 5. Adjustable setpoints through dial on face.
 - 6. 120 VAC, 125 VA rating.
 - 7. Contacts shall have proper ampere rating for intended use.
 - 8. NEMA 4X rated.
- B. Explosion-Proof Space Thermostats (Corrosive Environment)
 - 1. Product and Manufacturer: Provide one of the following:
 - a. Model HLT-2, as manufactured by TPI Corporation.
 - b. Model B121-120-M504, as manufactured by United Electric Controls Co.
 - c. Or equal.
 - 2. UL Listed for NEC Class I, Division 1 hazardous locations.
 - 3. Explosion-proof epoxy coated aluminum construction with local mount Type 316L stainless steel immersion stem.
 - 4. Complete with built-in thermometer.
 - 5. Thermostat Setpoint Range: 40 degrees F to 100 degrees F, with 2 percent of scale deadband.
 - 6. External temperature adjustment via reference dial.
 - 7. 120 VAC, 125 VA rating.

2.4 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.5 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.

- b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
- c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 INSTALLATION

- A. General:
 - 1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from Engineer in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
 - 2. Install in accordance with Laws and Regulations.
 - 3. Do not modify structures to facilitate installation of equipment, unless approved in writing by Engineer.
 - 4. Installation to conform to requirements of all local and state codes.

3.3 FIELD QUALITY CONTROL

- A. Field Tests:
 - 1. After equipment installation is complete, Contractor and a qualified field service representative of unit manufacturer shall perform an operating test of each unit and associated controls, in presence of Engineer. Equipment will pass the test when each unit and its controls are demonstrated to function correctly.
 - 2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
 - b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that

all controls work as intended. Successfully test-operate each equipment for at least 24 hours.

- c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing Contractor in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 ADJUSTING

- A. Adjust all controls for proper settings.
- B. Position unit as shown on the Drawings and adjust outlet louvers and diffusers for maximum throw.

3.5 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

- C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 05 05

GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to complete the electrical Work.
2. Temporary Utilities: CONTRACTOR shall provide temporary power and lighting in accordance with Section 01 51 05, Temporary Utilities.
3. Demolition: Electrical demolition shall be in accordance with Section 02 41 00, Demolition.
4. Utility Companies:
 - a. Electric Utility Company: Perform the Work in connection with the electric service and utility metering in accordance with requirements of United Illuminated Company.
 - b. Telephone and Communications Utility Company: Perform the Work in connection with telephone service and communications services in accordance with requirements of Frontier and Verizon.

B. Coordination:

1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.
2. Coordination and Intent of Electrical Drawings:
 - a. Dimensions on Drawings related to equipment are based on equipment of certain manufacturers. Verify the dimensions of equipment furnished to space available at the Site and allocated to the equipment.
 - b. Drawings show the principal elements of the electrical Work, and are not intended as detailed working drawings for the electrical Work. Drawings supplement and complement the Specifications and other Contract Documents relative to principal features of electrical systems.
 - c. Equipment and devices provided under this Contract shall be properly connected and interconnected with other equipment and devices for successful operation of complete systems, whether or not all connections and interconnections are specifically mentioned or shown in the Contract Documents.
 - d. Drawings are provided for CONTRACTOR's guidance in fulfilling the intent of the Contract Documents. CONTRACTOR shall comply with Laws and Regulations, including safety and electrical codes, and provide materials, equipment, appurtenances, and specialty items necessary for complete and operable systems.

3. Obtain from OWNER record drawings required to execute the Work.
 4. Field Coordination:
 - a. Provide materials, equipment, and services to interface with existing circuits. Field-verify system and equipment requirements prior to modifying existing systems.
 - b. Coordinate the interface of equipment with OWNER's personnel and field conditions.
 - c. Field-compare existing starter and panel control circuit terminations from record documents with existing circuits.
 - d. Field-trace existing circuits as required to interface the equipment provided.
 - e. Field-identify terminations for starters and panel controls for follow function for re-connection.
- C. Area Classifications:
1. Materials, equipment, and incidentals shall be suitable for the area classification(s) shown, specified, and required.
 2. Wet and Corrosive Locations: Comply with NEC and NEMA requirements for corrosive locations. Enclosures in corrosive locations shall conform to NEMA 4X requirements unless specified otherwise.
 3. Hazardous Locations: Comply with NEC requirements for the Class and Division designated.
 4. Dusty Locations: Indoor areas not designated as hazardous, corrosive, or wet are dusty locations. Comply with NEC and NEMA 12 requirements unless specified otherwise.

1.2 QUALITY ASSURANCE

- A. Qualifications:
1. Electrical Subcontractor:
 - a. Electrical Subcontractor shall have not less than five years experience installing electrical systems of the types required for the Project.
 - b. Electrical Subcontractor shall possess a valid electricians' and contractors' license in the jurisdiction where the Site is located.
 - c. Submit the following information for not less than three successful, completed projects: project name and location; year completed; name and contact information for: prime contractor for whom electrical Subcontractor worked, project owner, and project engineer or architect, including addresses and telephone numbers.
- B. Component Supply and Compatibility:
1. Materials and equipment similar to each other shall be from the same manufacturer for uniformity.

C. Regulatory Requirements:

1. Permits: Refer to the General Conditions, Supplementary Conditions, and other parts of the Contract Documents for responsibilities relative to obtaining and paying for permits, licenses, and inspection fees.
2. Codes: Refer to Section 01 42 00, References, for indication of applicable codes.

1.3 SUBMITTALS

A. General:

1. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section into the smallest number of submittals possible. Do not furnish partial submittals.
2. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.

B. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
 - b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
 - c. List of components including manufacturer's name and catalog number (or part number) for each.
 - d. Point-to point interconnection wiring diagrams.
2. Product Data:
 - a. Manufacturer's name and product designation or catalog number.
 - b. Electrical ratings.
 - c. Manufacturer's technical data and specifications.
 - d. Manufacturer's indication of compliance with applicable reference standards.
 - e. Painting and coating systems proposed.
3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing and field quality control testing.

C. Informational Submittals: Submit the following:

1. Manufacturer's Instructions:
 - a. Installation data and instructions.
 - b. Instructions for handling, starting-up, and troubleshooting.
2. Source Quality Control Submittals: Results for required shop testing.
3. Field Quality Control Submittals: Results for required field testing.
4. Qualifications:
 - a. Electrical Subcontractor.
 - b. Wiring coordinator, including information required of wiring coordinator in Paragraph 1.2.A of this Section.

D. Closeout Submittals: Submit the following:

1. Record Documentation:
 - a. System Record Drawings: Include the following:
 - 1) One-line wiring diagram of the electrical distribution system.
 - 2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
 - 3) Layouts of the power and lighting arrangements and the grounding system.
 - 4) Control schematic diagrams, with terminal numbers and control devices identified, for all equipment.
 - b. Point-to-Point Interconnection Wiring Diagram Drawings: Include the following:
 - 1) External wiring for each piece of equipment, panel, instrument, and other devices and wiring to control stations, lighting panels, and motor controllers.
 - 2) Numbered terminal block identification for each wire termination.
 - 3) Identification of the assigned wire numbers for all interconnections.
 - 4) Identification of wiring by the conduit tag in which the wire is installed.
 - 5) Terminal, junction, and pull boxes through which wiring is routed.
 - 6) Identification of equipment and the submittal transmittal number for equipment from which wiring requirements and termination information was obtained.
 - c. Record documents shall indicate final equipment and field installation information.

PART 2 – PRODUCTS

- A. Performance Criteria:
 1. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, with ambient outside air temperature of zero degrees F to 105 degrees F and an elevation of 100 feet above mean sea level.
 2. Unless specified otherwise, electrical equipment shall have ratings based on 75 degrees C terminations.
- B. Testing Laboratory Labels: Electrical material and equipment shall bear the label of Underwriters' Laboratories, Inc. or other nationally recognized, independent testing laboratory, where standards have been established and label service applies.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:

1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.

B. Staging, Sequencing, and Coordination with Existing Facilities:

1. Schedule, sequence, and install materials and equipment in accordance with Section 01 14 16, Coordination with Owner's Operations
2. Perform the Work in a manner that will not interfere with the existing equipment and facilities or cause interruption of the functions of the Site, unless specified otherwise or otherwise allowed by OWNER.
3. When operation of existing facilities and Site is disrupted due to CONTRACTOR's operations, comply with Section 01 14 16, Coordination with Owner's Operations, unless otherwise allowed by OWNER.
4. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of OWNER and ENGINEER.
5. Interruptions of existing circuits, not addressed in Section 01 14 16, Coordination with Owner's Operations, shall be coordinated with the OWNER who will determine the length of time a circuit may be de-energized to maintain the OWNER's processes in dependable and safe operation.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control – General:

1. Perform field quality control for electrical Work in accordance with the Contract Documents.

B. Site Tests:

1. Prior to requesting certificate of Substantial Completion, demonstrate to ENGINEER that electrical systems and electrically-operated equipment installed or modified under the Contract operates in accordance with the Contract Documents and operates as required
2. Perform the following operational tests on electrical systems:
 - a. Operate power circuits to verify proper operation and connection to electrical systems materials and equipment, including mechanical key-interlocks for circuit breakers.

- b. Remove and re-apply power supply to automatic transfer equipment to verify operation. Activate standby power systems to verify their automatic start-up, proper de-energization, and cool down upon resumption of normal power supply.
 - c. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.
 - d. Operate lighting systems and receptacle devices to verify proper operation and connections.
 - 3. Prepare and submit report on the equipment demonstration and operating field quality control tests. Report shall include complete information on the tests performed and results.
- C. Manufacturer's Services:
- 1. Furnish at the Site qualified, factory-trained representative(s) of equipment manufacturers for the services indicated in the Contract Documents.

+ + END OF SECTION + +

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling.
 - 2. Types of cabling required include:
 - a. Insulated cable for installation in raceways.
- B. Related Sections:
 - 1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - 2. ASTM B3, Specification for Soft or Annealed Copper Wire.
 - 3. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
 - 4. ASTM D3485, Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.
 - 5. ASTM F2160, Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
 - 6. NEMA TC 7, Smooth Wall Coilable Electrical Polyethylene Conduit.
 - 7. UL 44, Thermoset-Insulated Wires and Cables.
 - 8. UL 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 300, Wiring Methods.
 - 2. NEC Article 310, Conductors for General Wiring.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:

- a. Manufacturer's literature, specifications, and engineering data for low volt insulated cable proposed for use.
- B. Informational Submittals: Submit the following:
 - 1. Field Quality Control Submittals:
 - a. Written results of field insulation resistance tests.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Insulated Cable In Raceways:
 - 1. Application: Use for circuits located indoors and outdoors.
 - 2. Manufacturers: Provide products of one of the following:
 - a. Southwire.
 - b. The Okonite Company.
 - c. American Insulated Wire
 - d. General Cable
 - e. Or equal.
 - 3. Material: Single conductor copper cable complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW-2 or RHW-2 complying with UL 44.
 - 4. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
 - 5. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.
- B. Cable Connectors, Solderless Type:
 - 1. Products and Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Hylug.
 - c. Or equal.
 - 2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
 - 3. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
 - 4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
 - 5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.

C. Cable Splices:

1. Products and Manufacturers:
 - a. Compression-Type Splices: Provide one of the following:
 - 1) Burndy Hylink.
 - 2) T&B Color-Keyed Compression Connectors.
 - 3) Or equal.
 - b. Spring Connectors: Provide one of the following:
 - 1) Buchanan B-Cap.
 - 2) T&B Wire Connector.
 - 3) Or equal.
2. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.
3. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
4. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
5. Splices shall be suitably sized for cable, rated 90 degrees C, and 600 volts.

D. Wire and Cable Markers:

1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.

2.2 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Factory-test wire and cable in accordance with UL standards

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

B. Pulling:

1. Use insulating types of pulling compounds containing no mineral oil.
2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
3. Use dynamometer where mechanical means are used.
4. Cut off section subject to mechanical means.

- C. Bending Radius: Limit to minimum of six times cable overall diameter.
- D. Slack: Provide maximum slack at all terminal points.
- E. Splices:
1. Where possible, install cable continuous, without splice, from termination to termination.
 2. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
 3. Splices are not allowed in conduits.
- F. Identification:
1. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
 2. Identify power conductors by circuit number and phase at each terminal or splice location.
 3. Identify control and status wiring using numeral tagging system.
- G. Color-code power cables as follows:
1. No. 8 AWG and Smaller: Provide colored conductors.
 2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
 3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	rounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

3.2 FIELD QUALITY CONTROL

A. Site Tests:

1. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.
2. Individually test 600-volt cable mechanical connections after installation and before they are put in service, with calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.
3. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service, with Megger for one minute at voltage rating recommended by cable manufacturer or in accordance with ANSI/NETA ATS recommendations.
4. Insulation resistance for each conductor shall not be less than value recommended by cable manufacturer. Cables not meeting recommended value or that fail when tested under full load conditions shall be replaced with a new cable for full length.
5. Where existing cables are spliced to cables provided under the Project, test existing cables prior to splicing. Test cables at 1,000 vdc for one minute. Entire spliced cable installation shall be re-tested after splice is completed. Existing cable that fails or has value less than two megohms shall be brought to attention of ENGINEER and splicing shall not proceed until condition is acceptable.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 05 23

INSTRUMENTATION AND COMMUNICATION CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
2. Types of cables include the following:
 - a. Shielded instrumentation cables.
 - b. Telephone cables.
 - c. Data communication cables.

B. Related Sections:

1. Section 26 05 33.13, Rigid Conduits.
2. Section 26 05 53, Identification for Electrical Systems.

1.2 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:

1. “CPE” means chlorinated polyethylene.
2. “FEP” means fluorinated ethylene-propylene.
3. “XLPE” means cross-linked polyethylene.

1.3 REFERENCES

A. Standards referenced in this Section are:

1. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
2. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
3. ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling (requirements and restrictions of Technical Service Bulletins (TSBs) apply.)
4. TIA/EIA-485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems (known as RS-485).
5. UL 13, Power-Limited Circuit Cables.
6. UL 1581, Electrical Wires, Cables and Flexible Cords.
7. UL VW-1, Vertical Wire Flame Test.

8. UL 910, Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
 2. NEC 800, Communications Circuits.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.
- B. Informational Submittals: Submit the following:
 1. Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General:
 1. Cables shall bear the UL label.
- B. Single Shielded Pair Instrument Cables:
 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581.
- C. Multi-Paired Shielded Instrument Cables:
 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.

2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, twisted pairs with shield over each pair, stranded tinned no. 18 AWG copper drain wire, and overall PVC or CPE outer jacket. Rated for not less than 600 volts and complying with either UL 1581 or UL 13.
- D. Multi-Conductor Shielded Instrument Cables:
1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, stranded tinned no. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC or CPE jacket. Rated for not less than 600 volts.
- E. Multi-Conductor Shielded High-Temperature Instrument Cables:
1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 2. Silver-plated copper, extruded Teflon insulation, stranded conductors, not less than no. 16 AWG, with overall 90 percent silver-plated copper braid shield and overall Teflon tape-wrapped jacket. Rated for not less than 600 volts and complying with UL VW-1.
- F. Multi-Conductor Telephone Cables:
1. Manufacturers: Provide products of one of the following:
 - a. General Cable Company.
 - b. Belden
 - c. Or equal.
 2. Trunk and Extension Lines, Underground Installation:
 - a. Solid annealed copper, conductors, no. 24 AWG, polyethylene-insulated, with the number of twisted pairs as shown on the Drawings.
 - b. Assemble cable in groups of 25 pairs, filled with sealing compound and tape-wrapped with overlap.
 - c. Cable shall include aluminum shield, water blocking compound, and polyethylene jacket over all.
 - d. Rated for not less than 300 volts.
 3. Extension-Riser Lines, Indoor Insulation:
 - a. Solid annealed copper, conductors, no. 24 AWG, PVC- or polyethylene-insulated, with the number of pairs as shown on the Drawings.
 - b. Cable core shall be tape-wrapped with overlap and include aluminum shield and PVC jacket.
 - c. Rated for not less than 300 volts.
 4. Phones:

- a. Solid copper, no. 24 AWG, four conductor, PVC- or polyethylene-insulated, and PVC jacket.
- b. Rated not less than 300 volts.

G. Cable Terminals:

1. Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Insulug.
 - c. Or equal.
2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

H. Horizontal Unshielded Twisted Pair (UTP) Cables:

1. Horizontal cabling is cabling between and including the telecommunications outlet/connector and patch panel or termination block.
2. Manufacturers: Provide products of one of the following:
 - a. Bertek.
 - b. Belden.
 - c. Mohawk
 - d. Or equal.
3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, solid conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.
4. Comply with ANSI/TIA/EIA-568, Part 10.2.
5. Riser-rated where installed in conduit. Other installations shall be plenum-rated.
6. Rated for Category 6 use.

I. Patch Cords:

1. Patch cords are used for connecting patch panel to hub, or wall jack to equipment.
2. Manufacturer: Provide products of one of the following:
 - a. Bertek.
 - b. Belden.
 - c. Mohawk
 - d. Or equal.
3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, stranded conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.
4. Cables shall be riser-rated.
5. Rated for Category 6 use.
6. Cables shall incorporate integral strain relief into the connector at each end. Connectors shall be RJ45 plugs.
7. Provide the following patch cords:
 - a. One 10-foot cable per wall jack installed.
 - b. One 3-foot cable per every two wall jacks installed.

- c. One 5 foot cable per every two wall jacks installed.
- J. Connecting Hardware for Unshielded Twisted Pair (UTP) Cables:
 - 1. Hardware used to terminate UTP cable shall comply with ANSI/TIA/EIA-568, Part 10.4.
 - 2. Connecting hardware shall be compatible with wiring specified in the Contract Documents.
 - 3. Rated for Category 6 use.
 - 4. Connecting hardware shall utilize 110-type terminal blocks to coordinate with patch panels and termination blocks specified the Contract Documents.
 - 5. Telecommunications Outlets/Connectors:
 - a. Manufacturers: Provide products of one of the following:
 - 1) Hubbell.
 - 2) Or equal.
 - b. Outlets and connectors shall utilize RJ45 (eight-pin modular) plug/receptacle configuration.
 - c. Outlets and connectors shall utilize T568B pin/pair assignments, and be coordinated with wire type (solid or stranded conductor).
 - d. Outlets shall be flush-mount type or surface-mount type, as indicated on the Drawings.
- K. Patch Panels:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Black Box.
 - b. Or equal.
 - 2. Patch panels shall utilize RJ45 (eight-pin modular) plug/receptacle configuration, and utilize T568B pin/pair assignments for receptacles.
 - 3. Coordinate patch panel terminations with wire type (solid or stranded conductor).
 - 4. Patch panels shall be wall-mount type or rack-mount type, as indicated on the Drawings.
 - 5. Listed as Category 6.
 - 6. Provide quantity of ports not less than the quantity of wall jacks installed in the building/area served, plus 50 percent additional as spares.
- L. Cable Support Hardware:
 - 1. Conduit:
 - a. Where conduit is shown or indicated on the Drawings, comply with Section 26 05 33.13, Rigid Conduits.
- N. Modbus Cables (RS-232):
 - 1. Products and Manufacturers:
 - a. Non-Plenum-Rated Modbus Cables: Provide one of the following:
 - 1) Belden 8777.
 - 2) Or equal.
 - b. Plenum-Rated Modbus Cables: Provide one of the following:

- 1) Belden 88777.
 - 2) Or equal.
2. Cables shall consist of six tinned copper, no. 22 AWG, stranded conductors, polypropylene-insulated, twisted into three pairs, each pair individually shielded with 100-percent aluminum-polyester shield, one no. 22 AWG, stranded, tinned copper drain wire per pair, covered with an overall PVC jacket.
 3. Where plenum rating is required, cable insulation and jacket shall be FEP in lieu of insulation and jacket materials otherwise specified in this Section for Modbus cables.
 4. When portion of cable run is not contained in conduit or appropriate enclosure, cable shall be plenum- or riser-listed and marked in accordance with NEC 800.
- O. Modbus-Plus Cables:
1. Products and Manufacturers: Provide one of the following:
 - a. Non-Plenum-Rated Modbus-Plus Cables: Provide one of the following:
 - 1) Modicon 490-NAA-271-0x
 - 2) Belden 9842.
 - 3) Or equal.
 - b. Plenum-Rated Modbus-Plus Cables: Provide one of the following:
 - 1) Belden 82842.
 - 2) Or equal.
 2. Cables shall consist of two tinned copper no. 24 AWG, stranded conductors, polyethylene-insulated, and twisted into a single pair, with 100-percent aluminum-polyester shield, 90-percent tinned copper braided shield, no.24 AWG, tinned copper drain wire and overall PVC jacket.
 3. When plenum rating is required, cable insulation shall be FEP and jacket shall be fluorocopolymer, in lieu of insulation and jacket materials otherwise specified in this Section for Modbus-plus cables.
 4. When portion of cable run is not in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.
- P. Modbus RIO Cables:
1. Trunk Cables:
 - a. RG-11 coaxial.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Belden 3094A.
 - 2) Modicon 97-5951-000.
 - 3) Or equal.
 2. Drop Cables:
 - a. RG-6 coaxial.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Belden 3092A.
 - 2) Modicon 97-5950-000.
 - 3) Or equal.

Q. Fieldbus Type A Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3076F.
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 18 AWG, stranded conductors, polyolefin-insulated, and twisted into a single pair, 100-percent aluminum-polyester shield, no. 20 AWG tinned copper drain wire, and overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800

R. Fieldbus Type B Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3077F.
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 22 AWG, stranded conductors, polyolefin-insulated and twisted into a single pair, 100-percent aluminum-polyester shield, no. 20 AWG tinned copper drain wire, and overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800

S. Cutler-Hammer IMPACC Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden YR29090.
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 18 AWG, stranded conductors, polyethylene-insulated and twisted into a single pair, with 100-percent aluminum-polyester shield, 55-percent tinned copper braided shield, no. 20 AWG tinned copper drain wire, and overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

T. Cutler-Hammer I/Q System Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Non-Plenum-Rated Cables:
 - 1) Belden 9463.
 - 2) Or equal.
 - b. Plenum-Rated Cables:
 - 1) Belden 89463.
 - 2) Or equal.
2. Cables shall consist of two tinned copper, no. 20 AWG, stranded conductors, polyethylene-insulated and twisted into single pair, with 100-percent aluminum-polyester shield, 55-percent tinned copper braided shield, no. 20 AWG stranded tinned copper drain wire, and overall PVC jacket.

3. When plenum rating is required, cables insulation and jacket shall be FEP in lieu of insulation and jacket materials otherwise specified in this Section for Cutler-Hammer I/Q system cables.
4. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

U. Rotork Pakscan IIE Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3105A
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 22 AWG, stranded conductors, foam high-density polyethylene-insulated, twisted into single pair, with 100-percent aluminum-polyester shield and 90-percent tinned copper braided shield, tinned copper, no. 22 AWG, stranded drain wire, and overall ultraviolet-resistant PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

V. Limitorque Actuator Bus Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3105A.
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 22 AWG, stranded conductors, foam polyethylene-insulated, twisted into single pair, with 100-percent aluminum-polyester shield and 90-percent tinned copper braided shield, tinned copper no. 22 AWG stranded drain wire, and overall ultraviolet-resistant PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

W. Allen Bradley DH (Blue Hose) Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3072F.
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 18 AWG, stranded conductors, polyolefin-insulated and twisted into a single pair, with 100-percent aluminum-polyester shield, 55-percent tinned copper braided shield, no. 20 AWG stranded tinned copper drain wire, and overall PVC jacket.
3. When plenum rating is required, cable insulation and jacket shall be FEP in lieu of insulation and jacket materials otherwise specified in this Section for Allen Bradley DH (blue hose) cables.

4. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

X. ControlNet Cables:

1. Products and Manufacturers:
 - a. Non-Plenum-Rated ControlNet Cables: Provide one of the following:
 - 1) Allen-Bradley 1786-RG6.
 - 2) Belden 3092A.
 - 3) Or equal.
 - b. Plenum-Rated ControlNet Cables: Provide one of the following:
 - 1) Belden 3093A.
 - 2) Or equal.
2. Cables shall be RG-6/U-type coaxial cables.
3. Cables shall consist of no. 18 AWG solid, bare copper covered steel conductor, foam polyethylene-insulated, with four-layer shield: 100-percent aluminum-polyester, 60-percent tinned copper braided, 100-percent aluminum-polyester, 40-percent tinned copper braided, with overall PVC jacket.
4. When plenum rating is required, cable insulation shall be foam FEP and jacket shall be fluoro-copolymer, in lieu of insulation and jacket materials otherwise specified in this Section for ControlNet cables.
5. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

Y. Devicenet (Thick) Cables:

1. Product and Manufacturers: Provide one of the following:
 - a. Belden 3082A.
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 15 AWG, stranded power conductors, PVC-insulated, with 100-percent aluminum-polyester shield, two tinned copper no. 18 AWG stranded data conductors, foam polyethylene-insulated, and twisted into a single pair, with 100-percent aluminum-polyester shield, with no. 18 AWG stranded tinned copper drain wire. Cables shall be covered by overall 65-percent tinned copper braided shield, and sunlight- and oil-resistant overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

Z. Devicenet (Thin) Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3084A.
 - b. Or equal.
2. Cables shall consist of two tinned copper, no. 22 AWG, stranded power conductors, PVC-insulated with 100-percent aluminum-polyester shield, two

tinned copper no. 24 AWG stranded data conductors, foam polyethylene-insulated, and twisted into single pair, with 100-percent aluminum-polyester shield, with no. 22 AWG stranded tinned copper drain wire. Cables shall be covered by overall 65-percent tinned copper braided shield, and sunlight- and oil-resistant overall PVC jacket.

3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

AA. Profibus DP Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3079A.
 - b. Or equal.
2. Cables shall consist of two solid bare, no. 22 AWG, copper conductors twisted into a single pair, with flame-retardant foam polyethelene insulation, 100-percent aluminum-polyester shield, 65-percent tinned copper braid shield, and overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

BB. Profibus PA Cables:

1. Products and Manufacturers: Provide one of the following:
 - a. Belden 3076F.
 - b. Or equal.
2. Cables shall consist of two tinned copper stranded, no. 18 AWG, conductors, polyolefin-insulated, and twisted into a single pair, 100-percent aluminum-polyester shield, no. 20 AWG tinned copper drain wire, and overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

CC. RS-485 Half Duplex Cables:

1. Products and Manufacturers:
 - a. Non-Plenum-Rated RS-485 Half Duplex Cables: Provide one of the following:
 - 1) Belden 9841.
 - 2) Or equal.
 - b. Plenum-Rated RS-485 Half Duplex Cables: Provide one of the following:
 - 1) Belden 89841.
 - 2) Or equal.
2. Cables shall consist of two tinned copper stranded, no. 24 AWG, conductors, polyethelene-insulated and twisted into a single pair, 100-percent aluminum-polyester shield, 90-percent tinned copper braided shield, no. 24 AWG tinned copper drain wire, and overall PVC jacket.

3. When plenum rating is required, cables insulation shall be foam FEP and jacket shall be low-smoke PVC, in lieu of insulation and jacket materials specified in this Section for RS-485 half-duplex cables.
4. Cables shall comply with TIA/EIA RS-485.
5. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

DD. RS-485 Full Duplex Cables:

1. Products and Manufacturers:
 - a. Non-Plenum-Rated RS-485 Full Duplex Cables: Provide one of the following:
 - 1) Belden 9842.
 - 2) Or equal.
 - b. Plenum-Rated RS-485 Full Duplex Cables: Provide one of the following:
 - 1) Belden 82842.
 - 2) Or equal.
2. Cables shall consist of four tinned copper stranded, no. 24 AWG conductors, polyethylene-insulated and twisted into two pairs, 100-percent aluminum-polyester shield, 90-percent tinned copper braided shield, no. 24 AWG tinned copper drain wire, and overall PVC jacket.
3. Cables shall comply with TIA/EIA RS-485.
4. When plenum rating is required, cables insulation shall be foam FEP and jacket shall be low-smoke PVC, in lieu of insulation and jacket materials otherwise specified in this Section for RS-485 full duplex cables.
5. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
 1. Install cables complete with proper terminations at both ends.
 2. Install in conduit separate from power cables, unless shown or indicated otherwise.

3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
4. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
6. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

A. Site Tests:

1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
3. Replace with new cables the full length of cables that fail test.
4. Test equipment shall be provided by CONTRACTOR.
5. For testing of communications cables, test equipment used shall comply with the following:
 - a. Equipment shall consist of a "master" and a "remote" unit.
 - b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
 - c. Test unit shall be capable of storing all test results internally and printing the results later.
 - d. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.

+ + END OF SECTION + +

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems, structures, and equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
2. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
3. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Field Acceptance Testing Firm: Retain services of independent testing firm to perform acceptance field testing of grounding system. Testing firm shall have experience in testing grounding systems and shall be a member company of NETA.

B. Regulatory Requirements

1. National Electrical Code, (NEC).
 - a. NEC Article 250, Grounding and Bonding.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Listing of grounding connector types identifying where each will be used.
 - b. Layouts of each structure's ground grid.
 - c. Test point construction details.
2. Product Data:
 - a. Manufacturer's technical information for grounding materials proposed for use.
3. Testing Plans:
 - a. Ground resistance test procedure.

- B. Informational Submittals: Submit the following:
 - 1. Field Quality Control Submittals
 - a. Results of ground resistance tests at each test point.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Bare Ground Cable:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Cablec Corporation.
 - b. General Cable Corporation.
 - c. Southwire Cable Company.
 - d. Or equal.
 - 2. Material: Soft-drawn, bare copper stranded cable complying with ASTM B8. No. 4/0 AWG minimum size unless otherwise shown or indicated on the Drawings.
- B. Ground Rods:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Copperweld, Bimetallies Division.
 - b. ITT Blackburn Company.
 - c. Or equal.
 - 2. Material: Copper-clad rigid steel rods, 3/4-inch diameter, ten feet long.
- C. Grounding Connectors:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Pressure Connectors:
 - 1) O.Z./Gedney, Division of General Signal Corporation.
 - 2) Burndy Corporation.
 - 3) Or equal.
 - b. Welded Connections:
 - 1) Cadweld by Erico Products, Incorporated.
 - 2) Therm-O-Weld by Burndy Corporation.
 - 3) Or equal.
 - 2. Material: Pressure connectors shall be copper alloy castings, designed and fabricated specifically for items to be connected and assembled with Durium or silicone bronze bolts, nuts, and washers. Welded connections shall be by exothermic process utilizing molds, cartridges, and hardware designed specifically for connection to be made.
- D. Grounding Additive:
 - 1. Grounding additive, in its set form, shall have resistivity of not more than 20 ohm-cm.
 - 2. Product and Manufacturer:

- a. Ground Enhancement Material (GEM) by Erico
 - b. Or equal.
 - 3. Grounding additive shall be permanent and maintenance-free, without requiring recharging with salts or chemicals that may be corrosive, and shall maintain its earth resistance with time.
 - 4. Grounding additive shall set up firmly and not dissolve or decompose or otherwise pollute soil or groundwater.
 - 5. Grounding additive shall be suitable for installation in dry form or in slurry form.
 - 6. Grounding additive shall not depend on continuous presence of water to maintain its conductivity.
- E. Ground Test Well
- 1. Provide heavy-duty test well suitable for heavy-duty traffic.
 - 2. Manufacturer
 - a. Advanced Lightning Technology
 - b. Or equal.
 - 3. Diameter and Material: 12.75-inch outside diameter, Schedule 80 PVC.
 - 4. Depth: Two feet.
 - 5. Cover: Provide test well with cast iron cover marked, "Ground" with cast iron ring to support lid.
- F. Ground system components shall comply with UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions for the Work and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 STRUCTURE GROUND SYSTEM

- A. Provide ground grids as shown and indicated on the Drawings.
- B. Provide No. 4/0 bare copper cable around exterior perimeter of structures at not less than 2.5 feet below grade, unless otherwise shown or indicated on the Contract Documents.
- C. Connect grids to continuous underground water pipe system and existing electrical ground system.
- D. For new structures with concrete foundation or footings, connect structure's reinforcing steel or other concrete-encased electrode to grounding grid.

- F. Provide accessible test points for measuring the ground resistance of each grid.
- G. Weld all buried connections except for test points.

3.3 EQUIPMENT GROUNDING

- A. Ground electrical equipment in compliance with Laws and Regulations and the Contract Documents.
- B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where required for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.
- C. Control panels grounding conductors shall be bare stranded copper cable of adequate size to ground grid from AC ground bus, and an insulated stranded copper cable of adequate size to ground grid from DC ground bus.
- D. Connect ground conductors to conduit with copper clamps, straps, or with grounding bushings.
- E. Connect to piping by welding or brazing. Use copper bonding jumpers on gasketed joints.
- F. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use hold-down bolts. Where grounding provisions are not included, drill suitable holes in locations recommended by equipment manufacturer or designated by ENGINEER.
- G. Connect to motors by bolting directly to motor frames, not to soleplates or supporting structures.
- H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.
- I. Scrape bolted surfaces clean and coat with conductive oxide-resistant compound.

3.4 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Test completed grounding systems for resistance to ground using an electrical three-terminal ground resistance tester. Test all grounded cables and metal parts for continuity of connection. ENGINEER and OWNER will witness the testing.
 - 2. Grounding system maximum resistance shall not exceed five ohms under normally dry conditions when measured by resistance tester. Resistance values

above five ohms shall be brought to ENGINEER's attention. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each ground grid. Add grounding additive installing additional ground rods to increase their effectiveness.

3. Acceptance Testing:
 - a. Perform acceptance testing of grounding system. Testing shall be performed by testing firm in accordance with ANSI/NETA ATS.
 - b. Test Equipment, Calibration and Reporting: Test equipment, instrument calibration, and test reports shall comply with ANSI/NETA ATS.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 05 33.13

RIGID CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated and grounded raceway systems.
2. When specific, detailed conduit routings for various systems within buildings and other areas are not shown on the Drawings, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.
3. Conduit types and the installation methods shall comply with the following, unless otherwise shown or indicated in the Contract Documents:
 - a. Use steel conduit (rigid steel) for exposed indoor conduit runs in non-corrosive areas.
 - b. Use PVC-coated rigid steel or aluminum conduit for exposed interior or exterior conduit runs in hazardous, wet, and corrosive locations.
 - c. Use PVC-coated rigid steel conduit for individual conduits direct-buried in the ground.
 - d. Use Schedule 40 PVC or steel conduit for concrete-encased duct bank runs.
 - e. Use steel or Schedule 40 PVC conduit for conduit runs embedded in structural concrete slabs.
 - f. Use steel conduit for monitoring and control systems, system control and data acquisition (SCADA) systems, and communication systems, regardless of the installation. Conduit shall be PVC-coated rigid steel in hazardous, wet, and corrosive locations.

B. Coordination:

1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, light fixtures, and other systems and equipment and locate to avoid interferences.
2. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, waterstops, expansion joints, and other features of the concrete slab.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI C80.1, Standard for Rigid Electrical Steel Conduit (ERSC).

2. ANSI/NEMA FB1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
3. NEMA TC2, Electrical Polyvinyl Chloride (PVC) Conduit.
4. NEMA TC3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
5. NEMA TC14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
6. UL 6, Electrical Rigid Metal Conduit – Steel.
7. UL 514B, Conduit, Tubing, and Cable Fittings.
8. UL 651, Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.
9. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
10. UL 1242, Electrical Intermediate Metal Conduit – Steel.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
1. NEC Article 344, Rigid Metal Conduit.
 2. NEC Article 352, Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Assembly details of conduit racks and other conduit support systems.
 - b. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Shop Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of concrete slabs and locations of conduits relative to reinforcing steel, waterstops, and other features of the slab.
 2. Product Data:
 - a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.
- B. Informational Submittals: Submit the following:
1. Manufacturer's Instructions:
 - a. When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.
 2. Site Quality Control Submittals:
 - a. When requested by ENGINEER, provide copies of results of specified Site quality control testing.
- C. Closeout Submittals: Submit the following:
1. Record Drawings:

- a. Show actual routing of exposed and concealed conduit runs in record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Rigid Steel Conduit, Elbows, and Couplings:
 1. Manufacturers: Provide products of one of the following:
 - a. Allied Tube and Conduit.
 - b. Wheatland Tube Company.
 - c. Western Tube and Conduit Corporation.
 - d. Or equal.
 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
- B. PVC-coated Rigid Steel Conduit, Elbows, and Couplings:
 1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
 3. Color: Color of coating shall be the same on all conduit and fittings.
- C. Aluminum Conduit, Elbows, and Couplings:
 1. Manufacturers: Provide products of one of the following:
 - a. Allied Tube and Conduit.
 - b. Wheatland Tube Company.
 - c. Or equal.
 2. Material: Rigid, heavy-wall aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
- D. Metallic Conduit Fittings, and Outlet Bodies:
 1. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
 2. Material and Construction: Cast gray iron alloy, cast malleable iron or aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Materials shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use “LB” fittings. Use type “LBD” fittings where use of fittings is unavoidable.

3. Use: Conduits shall be gasketed and watertight in hazardous, wet, and corrosive locations.
- E. PVC-coated Conduit Fittings, and Outlet Bodies:
1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 2. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with factory coating of 40-mil thick PVC and smooth urethane interior coating. Units shall be threaded type with five full threads. Material shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
 3. Use: Provide PVC-coated or aluminum conduit fittings and outlet bodies in hazardous, wet, and corrosive locations. Fitting material shall be consistent with conduit material.
- F. Non-metallic Conduit and Fittings:
1. PVC Plastic Conduit:
 - a. Manufacturers: Provide products of one of the following:
 - 1) Amoco Chemicals Corp.
 - 2) Carlon Electrical Products.
 - 3) Or equal.
 - b. Material: Schedule 40 PVC, rated for 90 degrees C, complying with NEMA TC3 and UL 514B and 651.
 - c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.
- G. Conduit Hubs:
1. Manufacturers: Provide products one of the following.
 - a. Myers Electrical Products Company.
 - b. Or equal.
 2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.
 3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in areas designated as wet locations.
- H. PVC-coated Conduit Hubs:
1. Manufacturers: Provide products one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.

2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw, and factory coating of 40-mil thick PVC and smooth urethane interior coating.
 3. Use: Provide for PVC-coated steel or aluminum conduit terminations to boxes, cabinets, and other enclosures in areas designated as corrosive location.
- I. Conduit Bushings and Locknuts:
1. Manufacturers: Provide products one of the following:
 - a. O-Z/Gedney.
 - b. Appleton Electric Company.
 - c. Or equal.
 2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
 3. Locknuts: Steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
 4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.
- J. Thruwall Seals
1. For new construction through exterior subsurface walls and exterior concrete walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type WSK and WSCS by O-Z/Gedney.
 - 2) Or equal.
 2. For new construction passing through concrete floors and floor slabs.
 - a. Manufacturer: Provide one of the following:
 - 1) Type FSK and FSCS floor seals by O-Z/Gedney.
 - 2) Or equal.
 3. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
 - 2) Or equal.

2.2 ACCESSORIES

- A. Fasteners: To the extent possible, fastener material shall be consistent with conduit material. For PVC-coated rigid steel conduit runs, fasteners shall have factory applied PVC coating or be stainless steel. Fasten raceway systems to supporting structures using the following:
1. To Wood: Wood screws.

2. To Hollow Masonry Units: Toggle bolts, in accordance with Section 05 05 33, Anchor Systems.
 3. To Brick Masonry: Expansion bolts by Price, or equal.
 4. To Concrete: Anchors in accordance with Section 05 05 33, Anchor Systems.
 5. To Steel: Beam clamps in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
- B. Duct Sealing Compound
1. Soft, fibrous, slightly tacky, non-hardening sealing compound.
 2. Remains workable at all temperatures.
 3. Manufacturer:
 - a. Type DUX by O-Z/Gedney.
 - b. Or equal.

2.3 IDENTIFICATION

- A. Conduit Labels:
1. Provide conduit labels in accordance with Section 26 05 53, Identification for Electrical Systems.
- B. Warning Tape:
1. Provide warning tape in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install in accordance with Laws and Regulations.
- B. Supports:
1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
 2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.

- C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.
- D. Exposed Conduit:
1. Install parallel or perpendicular to structural members or walls.
 2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
 3. Install on structural members in protected locations.
 4. Locate clear of interferences.
 5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
 6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.
- E. Conduit Embedded in Structural Concrete:
1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
 2. Before placing concrete, arrange for observation of conduit installation by RPR or ENGINEER and make necessary conduit location measurements and provide required information on record documents.
 3. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:
 - a. Minimum concrete thickness shall be as follows:
 - 1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
 - 2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
 - 3) For concrete at foundation slabs, provide an one inch additional to minimum concrete thicknesses specified.
 - b. Conduit spacing shall be as follows:
 - 1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
 - 2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
 - 3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit
- F. Underground Conduits:
1. Install individual, underground conduits minimum of 20 inches below grade, unless otherwise shown or indicated.

2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Section (--1--), and Section 32 12 00, Flexible Paving.
 3. Install warning tape 12 inches below finished grade over buried conduits.
- G. Empty Conduits:
1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.
- H. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.
- I. Joints:
1. Apply conductive compound to joints before assembly.
 2. Make up joints tight and ground thoroughly.
 3. Use standard tapered pipe threads for conduit and fittings.
 4. Cut conduit ends square and ream to prevent damaging wire and cable.
 5. Use full threaded couplings. Split couplings are not allowed.
 6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
 7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where base metal is exposed.
- J. Terminations:
1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
 2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.
 3. Use of bushings in lieu of locknuts is not allowed.
 4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.
- K. Moisture Protection:
1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
 2. Underground and embedded conduit connections shall be watertight.
 3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
 4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
 5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.
- L. Corrosion Protection:
1. Conduit Curb:

- a. For conduits routed in concrete slabs or floors and stub-ups through floor, provide 2 inch high concrete curb, extending two inches from outer surface of conduit penetrating floor, to prevent corrosion. For floor-mounted equipment, concrete equipment base shall be in lieu of concrete curb.
- b. Conduit stub-ups shall be 90-degree, PVC-coated, rigid, galvanized steel conduit elbow. PVC-coated elbow shall extend a minimum of 1/2-inch above top of concrete curb or equipment base. Should elbow not reach specified height, provide PVC-coated conduit extension to accommodate specified requirements. Provide coupling or fitting for transition from rigid galvanized steel conduit or PVC conduit in slab to PVC-coated elbow.
- c. For conduits stubbing up and terminating at equipment enclosure mounted on concrete base, provide insulated grounding bushing on PVC-coated rigid steel elbow.
- d. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb in wet and dusty areas, provide conduit coupling/fittings between the PVC-coated rigid steel elbow and rigid steel conduit for transition between the two conduit types.
- e. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb or equipment base in corrosive areas, continue conduit system with PVC-coated rigid steel conduit
- 2. Dissimilar Metals:
 - a. Prevent occurrence of electrolytic action between dissimilar metals.
 - b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
 - c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.
- M. Reused Existing Conduits:
 - 1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
 - 2. Repeat swabbing until all foreign material is removed.
 - 3. Pull mandrel through conduit, if necessary, to remove obstructions.
- N. Core drill for individual conduits passing through existing concrete slabs and walls. Notify ENGINEER in writing in advance of core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit as indicated in Paragraph 3.2.K.3 of this Section.
- O. Non-metallic Conduit:
 - 1. Install in accordance with manufacturer's recommendations.
 - 2. Provide manufacturer's recommended adhesives or sealants for watertight connections.

3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
 4. Transition to PVC-coated rigid steel conduit before making turn up to enclosures.
- P. PVC-coated Rigid Steel Conduit:
1. Install in accordance with manufacturer's recommendations.
 2. Install with manufacturer's installation tools to avoid damage to PVC coating.
 3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.
- Q. Identify conduits, including spares, in accordance with Section 26 05 53, Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.
 2. Maintain a record, by number, of all conduits successfully tested.
 3. Repair or replace conduits that do not successfully pass testing, and re-test.

++ END OF SECTION ++

SECTION 26 05 33.16

FLEXIBLE CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 360, Liquid-Tight Flexible Steel Conduit.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 350, Liquid-Tight Flexible Metal Conduit.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Flexible Conduit (Non-hazardous Areas and Class 1, Division 2, Hazardous Areas):
 - 1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1.25-inch. Material shall be UL-listed.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Anaconda Sealtite Type UA by Anamet Electrical, Inc.
 - b. Liqueflex Type L.A. by Electric-Flex Company.
 - c. Or equal.
- B. Flexible Conduit (Class 1, Group D, Division 1, Hazardous Areas):

1. Material: Flexible brass inner core with bronze outer braid and protective neoprene plastic coating. Steel, brass, or bronze end fittings. Minimum of 12 inches long.
 2. Products and Manufacturers: Provide one of the following:
 - a. Type ECGJH or ECLK by Crouse Hinds Company.
 - b. Type EXGJH or EXLK by Appleton Electric Company.
 - c. Or equal.
- C. Flexible Conduit Fittings:
1. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
 2. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
 3. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.
- D. PVC-Coated Conduit Fittings:
1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections, and shall have an inside diameter not less than that of the corresponding standard conduit size.
 2. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Permacote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 3. Use: Provide on flexible conduit in areas designated as corrosive locations.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with the Laws and Regulations.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 26 05 33.23

SEALED FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit sealing fittings with sealing fiber and sealing compound.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations, Class 1, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 500, Hazardous (Classified) Locations.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of locations where fittings are to be used.
 - 2. Product Data:
 - a. Manufacturer's literature and technical information for sealing fittings, sealing fiber, and sealing compound proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Provide products of one of the following:
 - 1. Crouse Hinds Company.
 - 2. Appleton Electric Company.
 - 3. Or equal.
- B. Materials and Construction:
 - 1. Cast gray iron alloy, or cast malleable iron, or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.

2. Ample opening with threaded closure for access to conduit hub for making dam.
 3. In corrosive locations, fittings shall include factory-applied 40-mil PVC coating.
 4. Construct fitting to allow 40 percent cross-sectional fill.
- C. Sealing fiber for forming the dam within the hub and sealing compound shall be suitable for use with fittings furnished, and shall be products of fitting manufacturer.
- D. Sealing fitting, fiber, and sealing compound shall conform to UL 886.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install for hazardous locations as required by Laws and Regulations and as shown.
- B. Provide fittings for proper use relative to mounting position.
- C. Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

+ + END OF SECTION + +

SECTION 26 05 33.33

PULL, JUNCTION, AND TERMINAL BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.

B. Related Sections:

1. Section 26 05 05, General Provisions for Electrical Systems.
2. Section 26 05 29, Hangers and Supports for Electrical Systems.
3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are.

1. AASHTO, Standard Specifications for Highway Bridges.
2. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Manufacturer's technical information for pull, junction, and terminal boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Pull, Junction, and Terminal Boxes:

1. General – Applicable to All Boxes:
 - a. Description and Performance Criteria:

- 1) Provide pull, junction, and terminal boxes rated at not less than NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
- 2) For flush-mounted pullboxes in slabs or pavement potentially subject to vehicular traffic, boxes and covers shall be constructed for H-20 loading in accordance with AASHTO Standard Specifications for Highway Bridges.
- b. Manufacturers: Provide products of one of the following:
 - 1) Appleton Electric Company.
 - 2) Crouse-Hinds Company.
 - 3) Hoffman Engineering Company.
 - 4) Or equal.
- c. Materials: Pull boxes embedded in concrete slabs shall be cast iron.
- e. Terminal strips and terminal blocks in terminal boxes shall be mounted on terminal box sub-panels.
- e. Identification: Boxes shall be identified in accordance with Section 26 05 53, Identification for Electrical Systems.
2. Materials and Construction – Dusty Locations:
 - a. Material: Welded and galvanized sheet steel of USS gage.
 - b. Gasket: Oil-resistant gasket.
 - c. Access: Lift-off hinges and quick-release latches.
 - d. Material Thickness:
 - 1) Boxes with dimension two feet and smaller shall be 14-gage.
 - 2) Boxes with dimension between two and three feet shall be 12 gage.
 - 3) Boxes with dimension of three feet or more in any direction shall be 10-gage.
3. Materials and Construction - Wet, Corrosive, or Hazardous Locations:
 - a. Rating:
 - 1) Pull boxes in wet, corrosive, or outdoor areas shall be NEMA 4X.
 - 2) Boxes for areas classified as hazardous locations, where required by NEC, shall be explosion-proof and comply with UL 886.
 - b. Material:
 - 1) Cast gray iron alloy with hot-dip galvanized finish, or cast malleable iron bodies and covers.
 - 2) Large boxes not generally available in cast iron construction shall be copper-free aluminum alloy or Type 316 stainless steel, as required by location.
 - 3) In corrosive locations, where the conduit system is PVC-coated, boxes shall be cast metal with factory-applied 40-mil PVC coating, Type 316 stainless steel, or non-metallic thermoplastic or fiberglass reinforced plastic material.
 - c. Gasket:
 - 1) Provide neoprene gaskets for wet and corrosive locations.
 - 2) Gaskets shall be an approved type designed for the purpose. Improvised gaskets are not acceptable.

- d. Access: Stainless steel cover bolts.
 - e. Features:
 - 1) External mounting lugs.
 - 2) Drilled and tapped conduit holes.
 - 3) Boxes where conduits enter building or structure below grade shall have 1/4-inch drain hole at bottom of the box.
 - 4) Provide threaded connections for explosion proof boxes.
- B. Terminal Blocks:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Allen-Bradley Company, Bulletin, Model 1492.
 - b. General Electric Company, Model CR151K.
 - c. Or equal.
 - 2. Material and Construction:
 - a. NEMA-rated nylon modular terminal blocks.
 - b. 600-volt rated.
 - c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
 - d. Power terminals shall be copper and rated for the circuit ampacity.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.
- B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.
- C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:
 - 1. Conduit runs containing more than three 90-degree bends.
 - 2. Conduit runs exceeding 200 feet in length.
- D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.

- E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.
- F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.
- G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

+ + END OF SECTION + +

SECTION 26 05 33.36

OUTLET BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install outlet boxes for mounting wiring devices and lighting fixtures.

B. Related Sections:

1. Section 26 05 05, General Provisions for Electrical Systems.
2. Section 26 05 29, Hangers and Supports for Electrical Systems.
3. Section 26 05 53, Identification for Electrical Systems.
4. Section 26 27 26.13, Low-Voltage Receptacles.
5. Section 26 27 26.23, Snap Switches.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Fittings; and Handhole Enclosures.
2. NEC Article 501, Class I locations.
3. UL 514A, Metallic Outlet Boxes.
4. UL 514B, Fittings for Conduit and Outlet Boxes.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Manufacturer's technical information for outlet boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Device Boxes:

1. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
2. Material:

- a. In Wet Locations: Cast gray iron alloy or cast malleable iron with zinc electroplate finish, or aluminum bodies consistent with conduit material.
- b. In Dusty Locations: Zinc-coated sheet steel or aluminum bodies consistent with conduit material.
- c. Where conduit is installed concealed, boxes shall include suitable extension rings and covers, as required.
- d. Where used with PVC-coated conduit system, boxes shall include factory applied 40-mil-thick PVC coating.
- e. Cast boxes shall be hub-type and include external mounting lugs.
- f. Metallic outlet boxes shall comply with UL 514A.
- g. Fittings for outlet boxes shall comply with UL 514B.
- 3. NEMA rating of box shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
- 3. Cover Plates:
 - a. Type 302 stainless steel alloy for indoor finished areas.
 - b. Plates in corrosive locations shall include factory-applied 40-mil PVC coating.
 - c. Stainless steel screws and hardware.
 - d. For receptacle and switch cover plates, comply with Section 26 27 26.13, Low-Voltage Receptacles, and Section 26 27 26.23, Snap Switches.

B. Flexible Fixture Hangers:

- 1. For Class I, Division 1 Hazardous Areas:
 - a. Product and Manufacturers: Provide one of the following:
 - 1) Type EFH by Crouse-Hinds.
 - 2) Or equal
 - b. Materials:
 - 1) Iron alloy with electro-galvanizing and aluminum acrylic paint.
 - 2) Products shall have brass bellows and stainless steel spring.
 - 3) Product shall be capable of 15 degree swing from perpendicular in all directions.
 - 4) Product shall allow fixtures to be pendant-hung in accordance with NEC Article 501.130(A)
- 2. For Class I, Division 2 Hazardous Areas:
 - a. Product and Manufacturers: Provide one of the following:
 - 1) Type AHG by Crouse-Hinds.
 - 2) Or equal
 - b. Materials:
 - 1) Malleable iron top section and removable malleable iron bottom fixture support assembly with electro-galvanizing and aluminum acrylic paint.
 - 2) Include vapor-tight cushion to support fixture stem.
 - 3) Provide neoprene diaphragm to exclude moisture and dirt from conduit system.
 - 4) Provide with manufacturer's neoprene gasket between fixture hanger and box.
 - 5) Product shall be capable of eight-degree swing from perpendicular in

- all directions, before and after coating.
- 6) Product shall allow fixtures to be pendant-hung in accordance with NEC Article 501.130 (B).

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Fasten boxes rigidly and neatly to supporting structures.
- B. Securely fasten equipment to walls or other surfaces on which materials or equipment is mounted. Provide independent supports complying with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes are not mounted on walls or other surface capable of supporting the materials or equipment.
- C. For units mounted on masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.
- D. Leave no open conduit holes in boxes. Close unused openings with capped bushings.
- E. Label each circuit in boxes and identify each circuit in accordance with Section 26 05 53, Identification for Electrical Systems.
- F. Install outlet boxes in accordance with NEC Article 314.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 26 05 43.13

UNDERGROUND DUCTBANKS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install underground ductbanks.
- B. Coordination:
 - 1. Ductbank routing on the Drawings is diagrammatic. Coordinate installation with piping and other Underground Facilities and locate ductbanks clear of interferences.
 - 2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground ductbank Work.
- C. Related Sections:
 - 1. Section 31 21 00, Earth Moving.
 - 2. Section 03 00 05, Concrete.
 - 3. Section 26 05 26, Grounding and Bonding for Electrical Systems.
 - 4. Section 26 05 53, Identification for Electrical Systems.
 - 5. Section 26 05 33.13, Rigid Conduits.
 - 6. Section 26 05 33.26, Expansion/Deflection Fittings.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Layouts showing proposed routing of ductbanks and locations of manholes, handholes, and areas of reinforcement.
 - b. Profiles of ductbanks showing crossings with piping and other Underground Facilities.
 - c. Typical cross sections for each ductbank.
- B. Informational Submittals: Submit the following:
 - 1. Special Procedure Submittals:
 - a. Installation procedures.
 - 2. Field Quality Control Submittals:
 - a. Field test report.

- C. Closeout Submittals: Submit the following:

1. Record Drawings:
 - a. Include actual routing of underground ductbank runs on record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Duct: Provide conduit and fittings in accordance with Section 26 05 33.13, Rigid Conduits. Conduit types shall be as follows:
 1. Schedule 40 PVC conduits for power circuits.
 2. Galvanized rigid steel conduits for the following types of circuits: low voltage status, analog, and communication and SCADA
- B. Backfill: Provide backfill, including select backfill, in accordance with Section 31 21 00, Earth Moving.
- C. Reinforcing: Provide Ductbank reinforcing in accordance with Section 03 00 05, Concrete.
- D. Concrete: Provide ductbank concrete in accordance with Section 03 30 05, Concrete.
- E. Grounding: Provide ground cable in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.
- F. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes.
- G. Duct Sealing Compound:
 1. Products and Manufacturers: Provide one of the following:
 - a. O-Z/Gedney, Type DUX.
 - b. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Excavation and Backfilling:
 - 1. Provide excavation and backfilling for ductbank installation in accordance with Section 31 21 00, Earth Moving.
 - 2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or cables, or prevent adequate compaction of backfill.
- B. Ductbank Layout:
 - 1. Top of ductbank concrete shall be a minimum of 2.5 feet below grade, unless shown or indicated otherwise on the Drawings.
 - 2. Slope ductbank runs for drainage toward manholes and away from buildings with slope of approximately three inches vertical per 100 feet of run.
- C. Ductbank Assembly:
 - 1. Assemble ductbanks using non-magnetic saddles, spacers, and separators. Position separators to provide minimum three-inch concrete separation between outer surfaces of each conduit. Provide side forms for each ductbank.
 - 2. Make bends with sweeps of not less than four-foot radius or five-degree angle couplings.
- D. Concrete Placing:
 - 1. Provide minimum four-inch concrete covering on each side, top, and bottom of concrete envelopes around conduits. Concrete covering shall be as shown or indicated on the Drawings.
 - 2. Provide red dye in concrete for easy identification during subsequent excavation; all concrete in entire ductbank, including top and bottom, shall be dyed.
 - 3. Firmly fix conduits in place during concrete placing. Carefully place and vibrate concrete to fill spaces between conduits.
- E. Conduit Transitions:
 - 1. Conduit installations shall be watertight throughout entire length of ductbank.
 - 2. Transition from non-metallic to galvanized rigid steel conduit where ductbanks enter structure walls and slabs.
 - 3. Terminate conduits in insulated grounding bushings.
 - 4. Continue conduits inside buildings in accordance with Section 26 05 33.13, Rigid Conduits, and as shown or indicated in the Contract Documents.
 - 5. If ducts are not concrete-encased, provide expansion and deflection fittings in accordance with Section 26 05 33.26, Expansion/Deflection Fittings.
 - 6. Plug and seal empty spare conduits entering structures. Conduits in use entering structures shall be sealed watertight with duct sealing compound.

- F. Ductbank Reinforcing:
1. Provide reinforcing for all ductbanks:
 2. Install ductbank reinforcement as shown or indicated on the Drawings.
 3. Provide maximum clearance of 1.5 inches from bars to edge of concrete encasement.
- G. Connections to Structures:
1. Firmly anchor ductbanks to structure walls or slabs. Epoxy-grout ductbank rebar into structure concrete to eliminate shear forces between ductbank and structure wall concrete.
 2. Ductbank penetrations through structure walls shall be watertight.
- H. Grounding:
1. Provide bare stranded copper ductbank ground cable in each ductbank envelope. Make ground electrically continuous throughout entire ductbank system.
 2. Connect ground cable to building and station ground grid or to equipment ground buses. Also, connect ground cable to steel conduit extensions of underground ductbank system.
 3. Provide ground clamp and bonding of each steel conduit extension to maintain continuity of ground system.
 4. Terminate ground cable at last manhole or handhole for outlying structures.
- I. Detectable Underground Warning Tape:
1. Provide detectable underground warning tapes complying with Section 26 05 53, Identification for Electrical Systems, over the full length of each underground ductbank.
 2. Install warning tapes approximately 12 inches below grade.
 3. Provide multiple tapes across the width of each ductbank. Locate center of a warning tape above each edge of ductbank, and at intervals across top width of ductbank so that clear space between tapes does not exceed six inches.
- J. Reused Existing Ducts:
1. Pull rag swab through duct to remove water and to clean conduits prior to installing new cable.
 2. Repeat swabbing until all foreign material is removed.
 3. Pull mandrel through duct, if necessary, to remove obstructions.

+ + END OF SECTION + +

SECTION 26 05 45

UTILITY SERVICES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install electric and telephone services and associated equipment at the Site.
2. CONTRACTOR shall furnish and install the following Work regarding electric service:
 - a. Primary circuit conduits and associated underground duct banks. Contractor shall route conduit from duct bank 6 feet up riser pole.
 - b. Transformer concrete pads and associated grounding.
 - c. Secondary cable and terminations, conduits, and associated underground duct banks.
 - d. Utility meter socket and ct box
3. Electric utility company, will furnish and install the following:
 - a. Primary cable, terminations, and splices.
 - b. Transformers.
 - c. Ct's etc for utility meter
 - d. New utility pole
 - e. Demolition of existing utility poles.
4. The Contract Price includes an allowance amount specified in Section 01 21 00, Allowances, to be used for paying the electric utility company for construction costs incurred by electric utility company and invoiced to CONTRACTOR relative to electrical service for the Site.
 - a. For purposes of determining Cost of the Work and CONTRACTOR's fee associated with construction by the electric utility company, the electric utility company will be considered as a Subcontractor to CONTRACTOR.
 - b. Comply with Section 01 21 00, Allowances, regarding submittal of costs proposed to be paid under the allowance. Do not include in proposed payment under the allowance CONTRACTOR's cost other than cost invoiced to CONTRACTOR by electric utility company and CONTRACTOR fee (overhead and profit). Include such costs, if any, under other, non-allowance payment items.
 - b. Include in an Application for Payment costs invoiced to CONTRACTOR by electric utility company, accompanied by electric utility company's invoice to CONTRACTOR for construction associated with the electric service.
 - c. If costs payable under the allowance exceeds the allowance, OWNER will issue a Change Order to pay CONTRACTOR such extra amount,

or will pay CONTRACTOR such extra amount by other means available under the Contract.

- c. If actual invoiced costs are less than the allowance amount, the Contract Price will be reduced by the difference between cost eligible and recommended by ENGINEER for payment, and the allowance amount via a Change Order.
5. Coordinate with the telephone and cable companies on extension of wires to new utility pole. Provide new conduit and wire from interface points inside the building to the utility pole. Contractor shall route conduits up utility pole 6 feet. The location of where to route the conduits shall be in strict accordance with the spacing requirements of the utility.
6. Work in connection with electric, telephone and cable services shall be in accordance with requirements of the electric utility company and telephone company.

B. Coordination:

1. CONTRACTOR shall coordinate with electric utility company, local telephone and cable companies relative to electric, telephone and cable service connections and requirements. CONTRACTOR shall make all necessary arrangements with electric utility, telephone and cable companies.
2. The Contract Price as awarded includes all costs associated with providing electric service, telephone and cable services to the Site.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI C37.35, Guide for the Application, Installation, Operation and Maintenance of High Voltage Air Disconnecting and Load Interrupter Switches.
2. ANSI C37.46, Specifications for Power Fuses and Fuse Disconnecting Switches
3. ANSI/IEEE C62.11, IEEE Metal Oxide Surge Arresters of AC Power Circuits.
4. ANSI C135.1, Galvanized Steel Bolts and Nuts for Overhead Line Construction.
5. ANSI C135.2, Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction.
6. AWPAC4, Poles - Preservative Treatment by Pressure Processes.

1.3 QUALITY ASSURANCE

A. Pre-installation Conference:

1. Prior to transmitting submittals for materials and equipment related to electrical service or telephone service, and prior to installing materials and equipment associated with electrical service or telephone service, arrange a conference at the Site with the following:
 - a. Electric utility company and telephone company.
 - b. Supplier representatives (as required) for materials and equipment

- associated with electrical service or telephone service.
 - c. Installers of other work related to and adjacent to electric and telephone services Work.
 - d. ENGINEER and Resident Project Representative (as applicable).
 - e. Other representatives directly concerned with performance of electric service and telephone service Work.
- 2. Review at the conference the following relating to electrical service and telephone service Work:
 - a. Review Project requirements including Contract Documents, approved Shop Drawings and other submittals, requests for interpretation transmitted by CONTRACTOR to ENGINEER, and other pertinent documents.
 - b. Review scope of Work and scope of utility company work.
 - c. Review required samples and submittals, both completed and to be completed.
 - d. Review proposed costs for work that will be invoiced by utility companies.
 - e. Review status of Work related to utility services and Progress Schedule related to utility services.
 - f. Review availability of materials, tradesmen, equipment, and facilities required for progress, to avoid delays, and to protect the Work from damage.
 - g. Review required inspection, testing, certifying, and quality control procedures.
 - h. Review methods for complying with requirements of utility companies.
- 3. Reconvene conference at earliest opportunity if additional information must be developed to conclude the required topics of the conference.
- 4. Record in writing discussions of conference and decisions and agreements and disagreements; and revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them. Furnish copy of record to each party attending and the OWNER.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Drawings showing proposed layout of electrical utility service.
 - b. Drawings showing proposed layout of telephone service.
 - 2. Product Data:
 - a. Manufacturer's literature and technical information, including technical specifications, indicating compliance with the Contract Documents for materials and equipment and construction procedures specified in this Section.

PART 2 – PRODUCTS

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install electric service materials and equipment in accordance with requirements of electric utility company, and install telephone service materials and equipment in accordance with requirements of telephone company. Install materials and equipment in accordance with NESC.
- B. Install equipment in accordance with manufacturer's written recommendations.

+ + END OF SECTION + +

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

B. Related Sections:

1. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
2. Section 40 60 05, Instrumentation and Control for Process Systems.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 110, Requirements for Electrical Installation.
2. NEC Article 210, Branch Circuits.
3. NEC Article 215, Feeders.
4. NEC Article 504, Intrinsically Safe Systems.
5. NEC Article 702, Optional Standby Systems.
6. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
7. NFPA 70E, Electrical Safety in the Workplace.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings: Submit the following:
 - a. Complete description and listing of proposed electrical identification and electrical identification devices for associated equipment or systems.
 - b. Conduit and wire identification numbering system and equipment signage.
2. Product Data:
 - a. Manufacturer's literature, cut sheets, specifications, dimensions and technical data for all products proposed under this Section.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

- A. Engraved Identification Devices (Nameplates and Legend Plates):
1. Nameplates:
 - a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
 - b. Size: As required.
 - c. Letter Size: Minimum 3/16-inch.
 - d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.
 2. Legend Plates:
 - a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
 - 1) Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
 - b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.
- B. Safety Signs and Voltage Markers:
1. Provide high voltage signs for equipment operating over 600 volts.
 2. High-Voltage Safety Signs for Outdoor Applications:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-120-45471 by Brady.
 - 2) Or equal.
 - b. Unless otherwise shown or indicated, high voltage safety signs shall be not less than 10 inches high by 14 inches wide, of fiberglass reinforced plastic, and shall comply with 40 CFR 1910.145. Signs shall resist fading from exposure to temperature extremes, ultraviolet light, abrasive, and corrosive environments, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT"
 - c. Mounting hardware shall be Type 316 stainless steel.
 3. High-Voltage Safety Signs for Indoor Applications:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-84084 by Brady.
 - 2) Or equal.
 - b. High voltage safety signs for installation on indoor equipment shall be either pressure-sensitive acrylic or vinyl, and shall be not less than 10 inches high by 14 inches wide, shall comply with 40 CFR 1910.145, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT".
 4. Cable Tray Safety Signs:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-86139 by Brady.

- 2) Or equal.
- b. Cable tray safety signs shall be pressure-sensitive vinyl conforming to 40 CFR 1910.145, 5 inches by 3.5 inches in size, and shall read, "DANGER – HIGH VOLTAGE"
- 5. Low-Voltage Safety Signs:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-86060 by Brady.
 - 2) Or equal.
 - b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, "DANGER – 480 VOLTS".
- 6. Low-Voltage Markers:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) CV442xx by Brady.
 - 2) Or equal.
 - b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, "120 VOLTS", "208 VOLTS", "120/208 VOLTS", or "240 VOLTS" as required.
- C. Arc-flash Safety Signs:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Brady.
 - b. Or equal.
 - 2. Warning signs shall be adhesive-backed polyester.
 - 3. Warning signs shall read, "Warning – Arc Flash and Shock Hazard. Appropriate PPE Required. Arc flash warning signs shall indicate the flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.
- D. Voltage System Identification Directories:
 - 1. General:
 - a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
 - b. Directories shall identify all voltage systems within building or structure.
 - c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
 - d. Colors shall be in accordance with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables, Section 26 05 13.23, 15KV Cable, and Section 26 05 13.26, 5KV Cable.
 - e. Example Directory Text:

Voltage System Identification		
System	A, B, C	Neutral
277/480	Brown, Orange, Yellow	Gray
120/208	Black, Blue, Red	White

2. Large directories for rooms shall have text height not less than 1/2-inch.
3. Small directories for equipment shall have text height of not less than 1/4-inch.

E. Conduit Labels:

1. Products and Manufacturers: Provide one of the following:
 - a. B-915-xxxxx by Brady.
 - b. Or equal.
2. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit for conduit up through five-inch diameter, or pre-molded to conform to circumference of conduit six-inch diameter and larger.
3. Attach strap-on style for six-inch diameter conduit with stainless steel springs.
4. Shall be blank for use with custom printed labels.
5. Custom Labels:
 - a. Shall have black lettering on yellow background.
 - b. Shall not contain abbreviations in legend.
 - c. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.

F. Wire Identification:

1. Heat Shrinkable Wire and Cable Labeling System:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-341 PS-xxx-2W by Brady.
 - 2) Or equal.
 - b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
2. Wrap-Around Wire and Cable Labeling System:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) THT-XX-427 by Brady.
 - 2) Or equal.
 - b. Self-laminating white/transparent self extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.

G. Detectable Underground Warning Tape:

1. Products and Manufacturers: Provide one of the following:
 - a. Indentoline by Brady.
 - b. Or equal.
2. Material: Polyethylene or polyester with detectable metal core and polyester underlamine.

3. Width: Two inches.
 4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.
- H. Thermal Printing System:
1. Utilize thermal transfer process to provide non-smearing labels and markers.
 2. Wire and Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) TLS2200 by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) 200M by Brady.
 - 2) Or equal.
 3. Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) Handimark by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) Labelizer PLUS by Brady.
 - 2) Or equal.
- I. Generator System Warning Signs:
1. Generator warning signs shall be labeled in accordance with NEC Article 700, NEC Article 701, or NEC Article 702.
 2. Material, Colors, Letters: Plastic with white letters on red background. Letters shall be not less than 3/8-inch high.
 3. Attachment: Use stainless steel self-tapping screws.
 4. Location warning sign shall read, "WARNING – THIS SITE EQUIPPED WITH A NATURAL GAS DRIVEN STAND-BY GENERATOR".
 5. Generator ground warning sign shall read, "WARNING – GENERATOR GROUNDED CIRCUIT CONDUCTOR IS CONNECTED TO THE GROUNDING ELECTRODE CONDUCTOR IN THIS ENCLOSURE. DO NOT OPERATE GENERATOR WHILE EITHER CONDUCTOR IS DISCONNECTED TO AVOID SEVERE SHOCK HAZARD AND POSSIBLE EQUIPMENT DAMAGE."

2.2 FABRICATION

- A. Engraved Identification Devices (Nameplates and Legend Plates):
1. Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER after start-up and testing.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
 - 1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
 - 2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
 - 3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
 - 4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
 - 5. On switchgear, provide nameplates for each main and feeder circuit including control fuses, and for each indicating light and instrument.
 - a. Provide nameplate with 1.5-inch high letters giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number, and item number.
 - b. Identify individual door for each compartment with nameplate giving item designation and circuit number.
 - 6. Motor Control Centers:
 - a. Provide nameplate with 1.5-inch letters with motor control center designation.
 - b. Identify individual door for each unit compartment with nameplate identifying controlled equipment.
 - 7. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).
 - 8. Push Buttons:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Provide red buttons for stop function.
 - d. Provide black buttons for other functions.
 - 9. Pilot Lights:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	Legend
Green	Running, Open
Red	Stopped, Closed
Amber	Alarm
Blue	Power
White	Status

10. Selector Switches:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
11. Panel Mounted Instruments:
 - a. Provide nameplates for identification of function.
12. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
 - a. Provide nameplates for identification.
 - b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTOR's other submittals. Install nameplates with adhesive.
 - c. Interior items requiring nameplates include:
 - 1) Terminal blocks and strips.
 - 2) Bus bars.
 - 3) Relays.
 - 4) Rear of face-mounted items.
 - 5) Rear of door-mounted items.
 - 6) Interior mounted items that require identification when mounted externally.
 - d. Circuit Breaker Directory:
 - 1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.
13. Re-label existing equipment whose designation have changed.

C. Safety Signs and Voltage Markers:

1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
 - a. Install rigid safety signs using stainless steel fasteners.
 - b. Clean surfaces before applying pressure-sensitive signs and markers.
2. Install high voltage safety signs on all equipment doors providing access to uninsulated conductors, including terminal devices, greater than 600 volts.
3. Provide cable tray safety signs on both sides of cable trays at maximum intervals of 20 feet. Install signs on side rails of tray as acceptable to ENGINEER.
 - a. Label cable trays that contain conductors greater than 600 volts with cable tray safety signs.
 - b. Cable trays that contain conductors greater than 208 volts and less than 600 volts shall be labeled with low voltage safety signs.

- c. Cable trays that contain conductors of 120/208 volts shall be labeled with low voltage markers.
 - d. Do not label cable trays that contain only instrument signal cables.
 - e. Label cable trays that contain intrinsically safe wiring or cables in accordance with NEC Article 504.
 - 4. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.
 - 5. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.
- D. Voltage System Identification Directories
- 1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
 - 2. Provide in each electrical room voltage system identification directory mounted on wall or door at each entrance to room.
 - 3. For panelboards, switchboards, motor control centers, and other branch circuit or feeder distribution equipment that are not located in electrical rooms, provide voltage system identification directory mounted on equipment.
 - a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
 - b. Directories shall be readily visible and not obscure labels and other markings on equipment.
- E. Arc-flash Safety Signs:
- 1. Provide arc-flash safety signs as required by NEC Article 110.
 - 2. Provide signs for switchboards, panelboards, motor control centers, and industrial control panels. Provide signs for control panels that contain 480 volt equipment. Provide arc flash warning signs on other equipment where the incident energy is greater than 1.2 calories per square centimeter.
- F. Conduit Labels:
- 1. Provide conduits with conduit labels unless otherwise shown or indicated.
 - 2. Do not label flexible conduit.
 - 3. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment.
 - 4. Conduit labels shall indicate the following information:
 - a. Contract Number: Alphanumeric, three or four digits, as applicable.
 - b. Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabelled conduits, and in accordance with approved submittals.
 - 5. Conduits that contain intrinsically safe wiring shall have an additional pipe marker provided that has blue letters on white background and reads, "INTRINSICALLY SAFE WIRING".

- a. Install intrinsically safe pipe markers in accordance with NEC Article 504 along entire installation. Spacing between labels shall not exceed 25 feet.
 - 6. Provide conduit labels at the following locations:
 - a. Where each conduit enters and exits walls, ceilings, floors, or slabs.
 - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
 - c. At maximum intervals of 50 feet along length of conduit.
 - 7. Orient conduit labels to be readable.
- G. Wire and Cable Identification:
- 1. Color-coding of insulated conductors shall comply with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables, Section 26 05 13.23, 15KV Cable, and Section 26 05 13.26, 5KV Cable.
 - 2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
 - 3. Do not provide labels for the following:
 - a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
 - 4. Provide wire and cable labels for the following:
 - a. New, rerouted, or revised wire or cable.
 - b. Insulated conductors.
 - d. Wire and cable terminations:
 - 1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
 - 2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
 - a) Label individual conductors in a cable after breakout as specified for wires.
 - e. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
 - 1) Label wires or cables within two inches of entrance to conduit.
 - f. Wire or cable in junction boxes and pull boxes
 - 1) Label wires or cables within two inches of entrance to conduit.
 - g. Wire and cable installed in cable tray.
 - 1) Wire and cable shall have labels at maximum intervals of 20 feet.
 - h. Wire and cable installed without termination in electrical manholes.
 - 1) Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.
 - 5. Wire and Cable Identification System:
 - a. Wire and cable labels shall be imprinted with an identifying designator.
 - 1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.
 - b. Field Wiring:

- 1) Wire or cable designator shall consist of:
 - a) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.
 - b) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.
 - c) Remaining characters shall be alphanumeric and make wire designator unique.
 - d) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.
 - c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
 - 1) New Cabinets, Consoles, Panels, and Enclosures:
 - a) Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Section 40 61 13, Process Control Systems General Provisions.
 6. Modified Cabinets, Consoles, Panels, and Enclosures:
 - a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.
- H. Terminal Strip Labeling:
1. Label panel side of terminal to match panel wire number.
 2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.
- I. Generator System Warning Signs:
1. Provide warning signs for generator systems as required by NEC.
 2. Install generator location warning sign on or immediately adjacent to service equipment, or to “normal” source disconnecting means when generator is located out of sight of service equipment or disconnecting means.
 3. Install generator grounding warning sign on enclosure or immediately adjacent to point where generator neutral is connected to grounding electrode system if connection is made remote from generator.

+ + END OF SECTION + +

SECTION 26 05 73

ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, professional services, and incidentals required to perform electrical power distribution system studies.
2. Motor starting and transformer information used in electrical power distribution system studies shall be based on equipment provided by CONTRACTOR and, where applicable, existing equipment ratings and settings.
3. Electrical power distribution system studies shall include the following, as specified in this Section:
 - a. Short-circuit study.
 - b. Protective device evaluation study.
 - c. Protective device coordination study.
 - d. Arc flash analysis.

B. Related Sections:

1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers
2. ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment.
3. IEEE 141, Recommended Practice for Electric Power Distribution in Industrial Plants (IEEE Red Book).
4. IEEE 242, Recommended Practice for Protection and Coord. of Industrial and Commercial Power Systems (IEEE Buff Book).
5. IEEE 399, Analysis (IEEE Brown Book), Recommended Practice for Power System Analysis.
6. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
7. NFPA 70E, Electrical Safety in the Workplace.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Professional Engineer:

06532002.0000

26 05 73-1

- a. Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated. Professional engineer may be employed by independent consulting firm or manufacturer of power distribution equipment.
 - b. Professional engineer shall have not less than five years of experience performing electrical power distribution system studies similar in scope and size to the studies required for the Project.
 - c. Submit qualifications data.
 - d. Responsibilities include but are not necessarily limited to:
 - 1) Performing or supervising the performance of electrical power distribution system studies and related field services.
 - 2) Preparing or supervising the preparation of test plans and test reports, and interpretation and engineering analysis of test data. Test reports shall bear the seal and signature of the professional engineer. State of licensure, license number, and professional engineer's name shall be clearly legible on the seal.
 - 3) Certifying that tests performed and results achieved conform to the Contract Documents.
2. Field Engineer:
- a. Field engineer performing protective device testing shall be experienced in type of testing required and testing equipment used on the Project.
 - b. Field engineer may be an employee of the protective device equipment manufacturer.
- B. Test equipment and instrument calibration shall comply with accuracy standards of NIST and ANSI/NCSL Z540.3.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
- 1. Studies:
 - a. Calculations and results of the short-circuit study, protective device evaluation, and coordination studies in report format. Report shall be sealed and signed by the professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
 - b. Time current curves for protective devices included within the power system studies.
 - c. Calculations and results of arc-flash analysis in report format sealed and signed by professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
 - 2. Testing Plan: Submit work plan for field testing. Submit and obtain ENGINEER's approval prior to performing tests. Plan shall indicate schedule of field testing, time frames for tests, and duration of equipment

outage for testing. Submit shutdown requests for each outage in accordance with Section 01 14 16, Coordination with Owner's Operations.

3. Field Survey Plan: Submit work plan for field survey and data gathering prior to beginning work. Plan shall indicate the schedule of work, time frames for data collection, and duration that equipment will be temporarily out of service. Submit shutdown requests for each outage in compliance with Section 01 14 16, Coordination with Owner's Operations.

B. Informational Submittals: Submit the following:

1. Test Reports:
 - a. Results of field testing.
2. Qualifications Statements:
 - a. Professional engineer.
 - b. Field engineer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:

1. Final settings of protective devices. Submit compilation of final settings for each equipment lineup within 10 days of programming the associated protective devices.
2. Electronic Files:
 - a. Protective Devices:
 - 1) Settings for all microprocessor-based protective devices.
 - 2) Software versions used to program the protective devices.
 - b. Electrical Power Distribution System Studies:
 - 1) Upon ENGINEER's approval or acceptance, as applicable, of submittals required under this Section, submit for OWNER's use all electronic files developed for the Work under this Section associated with the approved or accepted, as applicable, submittal to ENGINEER.
 - 2) Electronic files submitted for OWNER's use shall become OWNER's property.
 - 3) Source files for power studies performed under this Section.

1.5 ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

A. General:

1. Perform a current and complete short-circuit study, protective device evaluation study, and protective device coordination study for the Site's electrical distribution system. Perform studies in accordance with IEEE 141, IEEE 242, and IEEE 399.
2. Studies shall include all portions of high-, medium-, and low-voltage electrical power distribution systems, from the normal and alternate sources of power through low-voltage distribution system. Thoroughly cover in the study normal system operating method, alternate operation, and operations that could result in maximum fault conditions.

3. Promptly bring to attention of ENGINEER and OWNER problem areas and inadequacies in equipment.
- B. Short-circuit Study:
1. Perform short-circuit evaluation using computer software specifically designed for such use.
 2. Input data shall include electric utility company's short-circuit, single-, and three-phase contributions, with reactance/resistance (X/R) ratio, resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other applicable circuit parameters.
 3. Calculate short-circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
 4. Short-circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, total duty on the bus and individual contribution from each connected branch, including motor back electromotive force (EMF) current contributions, shall be listed with its associated X/R ratio.
- C. Protective Device Evaluation Study:
1. Determine adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing short-circuit ratings of these devices with the available fault currents.
 2. Apply appropriate multiplying factors based upon system X/R ratios and protective device rating standards.
- D. Protective Device Coordination Study:
1. Perform study to select or to check selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
 2. Overcurrent device settings estimated in the protective device coordination study shall provide complete, 100 percent selectivity. Selectively coordinate system such that only the device nearest a fault will operate to remove the faulted circuit. System selectivity shall be based on both the magnitude and duration of a fault current.
 3. Study shall include all voltage classes of equipment starting at electric utility's incoming line protective device, down to and including medium- and low-voltage equipment. Phase and ground overcurrent and phase and ground fault protection shall be included, and settings for other adjustable protective devices.
 4. Plot time-current characteristics of installed protective devices on appropriate log-log paper. Maintain reasonable coordination intervals and separation of characteristic curves. Provide coordination plots for phase and

ground protective devices for complete system. Use sufficient curves to clearly indicate selective coordination achieved through electric utility's main breaker, power distribution feeder breakers, and overcurrent devices at each major load center.

5. Show maximum of eight protective devices per plot. Appropriately title each plot and include the following information as required for the circuits shown:
 - a. Representative one-line diagram, legends, and types of protective devices selected.
 - b. Power company's relays or fuse characteristics.
 - c. Significant motor starting characteristics.
 - d. Parameters of transformers, magnetizing inrush and withstand curves in accordance with ANSI C37.91.
 - e. Operating bands of low-voltage circuit breaker trip curves, and fuse curves.
 - f. Relay taps, time dial and instantaneous trip settings.
 - g. Cable damage curves.
 - h. Symmetrical and asymmetrical fault currents.
6. Provide selection and settings of protective devices separately in tabular format listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Provide a tabulation of recommended power fuse selection for all fuses in system.

E. Arc-Flash Analysis:

1. Conduct arc flash analysis after acceptance by ENGINEER of short-circuit study and coordination study. Perform arc flash analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
2. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following:
 - a. Bus and protection device name.
 - b. Bolted and arcing fault values.
 - c. Protective device trip times.
 - d. Arc flash boundary, working distance, and incident energy.
 - e. Required protective flame-resistant (FR) clothing class.

1.6 STUDY REPORT

- A. Summarize results of electrical power distribution system studies in a typed or computer-printed report that includes the following:
 1. Description, purpose, basis, written scope, and single-line diagram of power distribution systems evaluated.
 2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties. Evaluation of short-circuit calculations and identification of underrated equipment.

3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and fuse selection. Include an evaluation and discussion of logical compromises for proposed protection.
 4. Fault current tabulation including definition of terms and guide for interpretation.
 5. Tabulation of appropriate tap settings for relay seal-in units.
 6. Tabulation of equipment survey information.
- B. Electrical power distribution system studies report shall include a separate section addressing arc flash analysis. In addition to protection and calculation procedures, and coordination review and analysis results, report shall include protective device evaluation for each high-incidence energy case to determine if adjustments can improve system performance relative to arc flash hazard level.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

- A. General:
1. Coordinate with professional engineer performing the studies and assist professional engineer with collecting information necessary to complete the specified studies.
 2. Prior to performing studies, obtain information pertaining to existing system necessary for performing studies.

3.2 FIELD SERVICES

- A. CONTRACTOR's professional engineer shall conduct an equipment survey and data gathering of existing devices and information necessary to perform electrical power distribution system studies.
- B. To the extent applicable, perform survey that includes the following information:
1. Manufacturer, type, and size of each power fuse.
 2. Manufacturer, type, model, and settings for each protective relay, trip unit, and circuit breaker.
 3. Current transformer ratios for each protective relay.
 4. Appropriate data for motors and transformers included with the study.

3.4 FIELD TESTING

- A. Site Tests:

1. Provide protective device field testing in accordance with manufacturers' recommendations. Field testing shall be by CONTRACTOR's field engineer, after submittal of and ENGINEER's acceptance of electrical power distribution system studies. Field testing results shall be documented in a report that shall include final settings of protective devices.
2. Field engineer shall provide necessary tools and equipment and adjust, set, calibrate, and test protective devices. Protective relays and meters in medium- and low-voltage equipment shall be set, adjusted, calibrated, and tested in accordance with manufacturers' recommendations and the coordination study. Provide minor adjustments, repairs, and lubrication necessary for proper operation.
3. Solid state and multi-function trip devices shall be set, including required programming necessary for the protection required. Devices shall be checked, configured, and tested for setting and proper operation.

3.5 MAINTENANCE OF OPERATIONS

- A. Field testing may require that certain equipment be temporarily taken out of service. CONTRACTOR shall perform the Work with due regard to the need of OWNER for continuance of operations and in accordance with sequencing required in the Contract Documents, and in accordance with Section 01 14 16, Coordination with Owner's Operations. Submit testing procedures and schedules and obtain acceptance by ENGINEER prior to starting testing and related Work.

3.6 INSTALLATION

- A. Provide personnel protective equipment labels in accordance with Section 26 05 53, Identification for Electrical Systems.
 1. Supplier Services: Provide training for OWNER's operation and maintenance personnel in personnel protection equipment. Provide at least eight hours of training, in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE++

SECTION 26 22 14

DRY-TYPE LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install dry type low-voltage distribution transformers.

B. Related Sections:

1. Section 26 05 05, General Provisions for Electrical Systems.
2. Section 26 05 26, Grounding and Bonding for Electrical Systems.
3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. NEMA ST-20, Dry Type Transformers for General Applications.
2. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.
3. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption for Distribution Transformers.
4. UL 1561, Dry Type General Purpose and Power Transformers.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NEC Article 450, Transformers and Transformer Vault (Including Secondary Ties).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Schedule of transformers to be furnished with ratings and other required technical data.
 - b. Proposed location for each transformer, including pad layout, dimensions, and appurtenances.
2. Product Data:
 - a. Supplier's technical information for transformers proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Dry Type Two-Winding Transformer:

1. Type: Dry type, air cooled, low temperature rise. Transformers 15 kVA and larger shall be energy efficient, complying with NEMA TP-1 Class 1 efficiency levels. Transformers less than 15 kVA shall be general purpose.
2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
3. Insulation: Insulation and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA per the following table. Energy efficient transformers shall be capable of 15 percent continuous overload at 150 degrees C temperature rise.

kVA Rating	Insulation Class (degrees C)	Temperature Rise (degrees C)
1 to 15 kVA	185	115
25 to 500 kVA	220	115

4. Winding Taps, Transformers 15 kVA and Less: Two 5-percent below rated voltage, full capacity taps on primary winding.
5. Winding Taps, Transformers 25 kVA and Larger: Two 2-1/2-percent above rated voltage and four 2-1/2+ percent below rated voltage, full capacity taps on primary.
6. Basic impulse level shall be 10 kV.
7. Sound Level: NEMA ST-20 standard.
8. Enclosure: UL listed for the application.
9. Identification: Identify transformers in accordance with Section 26 05 53, Identification for Electrical Systems, with the transformer number and voltages, connection data, kVA ratings, impedance, and overload capacity.
10. Transformers shall comply with NEMA ST-20, NEMA TP-1, NEMA TP-2, and UL 1561.
11. Transformers shall bear the label of the Underwriters' Laboratories, Inc.

B. Manufacturers: Provide products of one of the following:

1. Cutler-Hammer.
2. General Electric Company.
3. Square D Company.
4. Siemens.
5. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the conditions under which the dry type transformers are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on walls or floors at locations shown. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for convenient and safe operation and maintenance.
- B. Mount transformers so that vibrations are not transmitted to the building structural parts and other equipment. Make connections to transformers with flexible conduit.
- C. Adjust tap settings to provide proper voltage at panelboards.
- D. Install dry type transformers in conformance with governing codes and manufacturer's instructions and recommendations, and the Contract Documents.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 24 16

PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install panelboards.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 22 14, Dry-Type Low-Voltage Distribution Transformers
 - 4. Section 26 43 00, Surge Protective Devices.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NEMA PB 1, Panelboards.
 - 2. UL 67, Panelboards.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of panelboards to be furnished with identification of their proposed location, and all electrical characteristics, including number and rating of branch circuit breakers and enclosure type.
 - 2. Product Data:
 - a. Manufacturer's technical information for panelboards proposed for use, including product literature and specifications. Indicate options and features to be provided.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements; Comply with the following:
 - 1. NEC Article 408, Switchboards and Panelboards.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Packing:

- a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
 - b. Protect mating connections.
 - c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
 2. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work. Upon deliver, check materials and equipment for evidence of water that may have entered equipment during transit.
 3. Comply with Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
1. Store panelboards in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
 2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Panelboards:
1. Manufacturers: Provide products of one of the following:
 - a. General Electric Company.
 - b. Eaton/Cutler-Hammer.
 - c. Schneider Electric/Square D Company.
 - d. Or equal.
 2. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles as shown or indicated on the Drawings.
 3. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown or indicated. Where indicated on the Drawings, circuit breakers shall be ground fault circuit interrupting type equipped with solid state sensing and five-milliamp sensitivity.
 4. Circuit breakers for 480-volt panelboards shall have minimum interrupting rating of 22,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Circuit breakers for other panelboards shall have minimum interrupting rating of 22,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings.
 5. Bus Bars: Bus bars shall be 98 percent conductivity copper. Four-wire panelboards shall have solid neutral bar. Each panel shall have ground bus bar.
 6. Main: Panelboards shall have main circuit breaker, unless the Drawings specifically indicate main lugs only.
 7. Connect branch circuit breakers for sequence phasing.
 8. Enclosures: Panel enclosures shall be as required for the area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.

9. Construction: Code-grade steel, ample gutter space, flush door, flush snap latch and lock. Panelboards shall comply with NEMA PB 1 and UL 67.
10. Trim: Surface or flush as required.
11. Directory: Typed or computer-printed card, with transparent protective cover in frame on back of door giving circuit numbers and area or equipment served.
12. Identification: Identify panelboards in accordance with Section 26 05 53, Identification for Electrical Systems. Identification shall indicate panel number and voltage.
13. Directory of Existing Panelboards: When adding or removing breakers or loads from existing panelboards, provide a new typed or computer-generated directory card, indicating the circuit numbers and equipment served.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Mounting: Install panelboards at locations shown or indicated. Set cabinets so that top branch circuit breaker is not over six feet above the floor.
- B. Directory: Complete typewritten or computer-printed directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.
- C. Arrange circuits to balance the loads on the panelboards.
- D. Identify panelboards in accordance with Section 26 05 53, Identification for Electrical Systems.
- E. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Verify proper installation prior to energizing panelboards.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install motor control centers
- B. Coordination:
 - 1. To properly size circuit breakers, starters, and control power transformers, obtain motor nameplate data on equipment being furnished under this and other contracts as required.
 - 2. To properly size control power transformers, obtain data on motor space heater and other accessories.
 - 3. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before motor control center Work.
- C. Related Sections:
 - 1. Section 26 05 53, Identification for Electrical Systems.
 - 2. Section 26 05 73, Electrical Power Distribution System Studies.
 - 3. Section 26 36 23, Automatic Transfer Switches.
 - 4. Section 26 43 00, Surge Protective Devices

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/IEEE C37.2, Electrical Power System Device Function Numbers and Contact Designations.
 - 2. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - 3. NEMA ICS 18, Motor Control Centers.
 - 4. NEMA ICS 1, Industrial Controls and Systems: General Requirements.
 - 5. UL 845, Motor Control Centers.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Shall have not less than five years experience of producing equipment substantially similar to that required and shall be able to submit documentation of not less than five installations in satisfactory operation for at least five years each.
 - 2. Independent Field Testing Firm:

- a. Retain an independent testing firm to perform field acceptance testing of motor control centers.
 - b. Testing firm and its assigned personnel shall be experienced in inspecting and testing motor control centers.
 - c. Testing firm shall be a member company of NETA.
- B. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 430, Motors, Motor Circuits, and Controllers.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Outline and summary sheets with schedules of equipment in each unit.
 - b. One-line diagrams indicating circuit breaker sizes, bus rating, motor controller ratings, and other pertinent information to demonstrate compliance with the Contract Documents.
 - c. Unit control schematic and elementary wiring diagrams showing numbered terminal points and interconnections to other units.
 - 2. Product Data:
 - a. Manufacturer specifications, cut sheets, dimensions, and technical data for all components, materials, and equipment proposed for use.
 - 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Not less than 30 days prior to actual factory testing, submit proposed testing methods, procedures, and apparatus.
 - b. Not less than 30 days prior to actual field testing, submit proposed testing methods, procedures, and apparatus.
- B. Informational Submittals: Submit the following:
 - 1. Supplier Instructions:
 - a. Instructions for shipping, storing and protecting, and handling the materials and equipment.
 - b. Installation data for the equipment, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
 - c. Instructions for start-up and troubleshooting.
 - 2. Source Quality Control Submittals:
 - a. Reports of completed factory testing, including procedures used and test results.
 - 3. Site Quality Control Submittals:
 - a. Reports of completed field testing, including procedures used and test results.
 - 4. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.

5. Qualifications Statements:
 - a. Independent testing firm.
 - b. Manufacturer, when requested by ENGINEER.
- C. Closeout Submittals: Submit the following:
 1. Operations and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
 - c. Comply with Section 01 78 23, Operations and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
 1. Spare Parts:
 - a. Furnish, tag, and box for shipment and long term storage the following spare parts and special tools for each motor control center lineup furnished:

Item	Quantity per Switchgear Lineup Furnished
1) Starters and feeder breakers	Quantities and sizes as shown
2) Fuses	Six of each type and size used
3) Auxiliary control relays	Two, with at least two normally open and two normally closed contacts
4) Control power transformers	Two of each size used
5) Indicating lamps	Twelve
6) Covers for indicating lamps	Six of each color used
7) Starters: Contact kits for Size 1 motor starter	Five sets
8) Starters: Contact kits for Size 2, Size 3, and Size 4 motor starters	One set of each size

- b. Furnish a list of additional recommended spare parts for an operating period of one year. Describe each part, the quantity recommended and current unit price.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 1. Packing:
 - a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
 - b. Protect mating connections.

- c. Indoor containers shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
 - d. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
 - 2. Upon delivery, check materials and equipment for evidence of water that may have entered equipment during transit.
 - 3. Handling:
 - a. Lift, roll or jack motor control center equipment into locations shown.
 - b. Motor control centers shall be equipped to be handled by crane. Where cranes are not available equipment shall be suitable for placement on rollers using jacks to raise and lower the groups.
- B. Storage and Protection:
- 1. Store motor control center equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide equipment by one of the following:
- 1. General Electric Company.
 - 2. Schneider Electric/Square D Company.
 - 3. Eaton/Cutler-Hammer.
 - 4. Allen-Bradley
 - 5. Or equal.

2.2 MATERIALS

- A. General: Motor control center lineups shall comply with NEMA ICS 18 and be provided as shown with the following ratings:
- 1. Service: Voltage rating and number of wires shall be as shown or indicated on the Drawings. Motor control center shall operate from a three-phase, 60 Hertz system.
 - 2. Wiring: NEMA Class II, Type B.
 - 3. Enclosure: NEMA 1
 - 4. Interrupting Capacity Rating: Motor control center shall have an interrupting capacity rating as shown or indicated on the Drawings. Devices shall be suitable for minimum rating indicated.
 - 5. Motor control center lineups shall be UL-rated as suitable for service entrance where shown or indicated on the Drawings and as required.
- B. Construction: Provide equipment with the following:

1. Totally-enclosed structure, dead front, consisting of nominal 20-inch deep, 20-inch wide, 7.5-feet high vertical sections bolted together to form a unit assembly.
2. Vertical sections shall have side sheets extending the full height and depth of section.
3. Removable lifting angles for each shipping section.
4. Two removable floor sills for mounting.
5. Horizontal wireways top and bottom, isolated from horizontal bus and readily accessible.
 - a. Wireway openings between sections shall have rounded corners and rolled edges.
6. Isolated vertical wireways with cable supports, accessible through hinged doors, for each vertical section.
 - a. Wireway shall be separate from each compartment and remain intact when compartment is removed.
7. All-metal non-conducting parts electrically continuous.
8. Comply with NEMA ICS 18.

C. Bus System:

1. Rating: Bus bracing and bus current capacities as shown or indicated on the Drawings.
2. Bus bars shall be tin-plated, copper-rated, and comply with UL heat rise standards.
3. Bus bar connections shall be easily accessible with simple tools.
4. Main Horizontal Bus:
 - a. Continuous, edge-mounted, and isolated from wireways and working areas.
 - b. Mount the bus in vertical center of motor control center to provide easy access and even heat distribution.
 - c. Bus shall be supported, braced, and isolated by high-strength, non-tracking, FRP material.
5. Vertical Bus:
 - a. Continuous, and isolated by glass polyester barrier.
 - b. Rated for 300 amperes continuous minimum, and at least equal to full-load rating of all installed units in the associated stack.
6. Grounding Bus: Full length mounted across the bottom, drilled with lugs of appropriate capacity as required.
7. Neutral Bus: Insulated, continuous through control center for four-wire services, drilled with lugs of appropriate capacity as required.

D. Unit Compartments:

1. Provide individual front door for each unit compartment. Fasten door to stationary structure, instead of the unit itself, so that door can be closed when unit is removed.
2. Starter and feeder unit doors interlocked mechanically with unit disconnect device to prevent unintentional opening of door while energized and

unintentional application of power while door is open, with provisions for releasing interlock for intentional access and application of power.

3. Padlocking arrangement permitting locking disconnect device in the "OFF" position with at least three padlocks with door closed or open. Equip unit disconnect devices located in the top compartment, compartment sized 12 inches or higher, with extender handle complying with UL 845. Extender handle shall allow disconnect operating handle to be located above NEC's height limitation of six-feet, seven-inches above floor.
4. Equip compartments as shown or indicated on the Drawings:
 - a. Blank compartments, unused space, and compartments shown or indicated on the Drawings as "SPACE" shall have bus covers and be complete with necessary hardware for future installation of a plug-in unit.
 - b. Provide shutters for each compartment that automatically open when unit is inserted and automatically close when unit is removed.
5. Provide wiring and device identification:
 - a. Identify compartment doors, devices, and field wiring in accordance with Section 26 05 53, Identification for Electrical Systems.
 - b. Identify internal control conductors with permanent wire markers. Each wire shall be identified by a unique number attached to wire at each termination point.
 - c. Identify internal control devices with permanent markers. Each device shall be identified by a unique number attached to each device.
 - d. Numbering system for each wire and control device shall be identified on the wiring diagrams in the Shop Drawings and shall reflect the actual designations used in the Work.
6. NEMA 1 minimum motor starter size. Starter units completely draw out type in Sizes 1 and 2 and draw out type after disconnecting power leads only in Sizes 3 and 4.
7. Motor starters shall be NEMA-rated and include magnetic contactor, with encapsulated magnet coils. Wound coils are unacceptable. Control shall be 120 vacac unless indicated otherwise.
 - a. Starters shall be full-voltage non-reversing unless shown or indicated otherwise on the Drawings.
8. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with the following:
 - a. Thermal Overload Relays: Relays shall be thermal, bimetallic type, direct or current sensing. Relays shall include ambient compensation and be equipped with separate heater elements sized for full-load amperes and service factor of actual motors furnished.
 - b. Each overload relay shall be manual reset type and shall include provisions for resetting by an insulating button on front of starter unit door.
 - c. Each overload relay shall include a normally-open auxiliary contact for remote alarm purposes.
 - d. Size each overload relay for full-load amperes and service factor of actual motors installed.

9. Individual control power transformers for all starters, capacity as required for all control circuit devices, 100 VA minimum, Class A insulation, two primary fuses, 120-volt secondary, one secondary fuse, and the other secondary leg grounded.
11. Motor horsepower shown are preliminary. Circuit breaker trips and starter overload heaters to be coordinated with the actual equipment installed.
12. Auxiliary contacts, relays, timers as required for specified control functions and those shown on Drawings.
13. Starter devices, including spare contacts, shall be wired to numbered terminal blocks.
14. Terminal blocks for field connections to unit compartments shall be plug-in/pull-apart type. Terminals shall be fully accessible from the front. Terminals shall be mounted near the front of vertical wireway.
15. Control devices shall be 600-volt heavy duty, NEMA A600. Relays shall have convertible contacts. Pilot devices shall be oiltight. Pilot lights shall be transformer type with six-volt secondary.
16. Feeder Circuit Breakers: Thermal magnetic type.
 - a. Circuit breakers of 100 amp frame or less shall be mounted in a dual mount compartment (two breakers in one space factor) or shall mount in one-half space factor, unless otherwise shown or indicated on the Drawings.
17. Motor Starter Circuit Breakers: Magnetic trip only motor circuit protectors.
18. Provide the following diagrams and tables inside of door for each compartment:
 - a. Elementary wiring diagram.
 - b. Table of overload heater sizes with correct heater highlighted.
 - c. Table of motor circuit protector settings with correct setting highlighted.
19. Main and Tie Circuit Breakers: Thermal magnetic, molded case type, unless shown or indicated otherwise. Where shown or indicated, equip main and tie breakers with key interlocking. Interlocking shall allow only two of the three breakers to be closed at a time. Provide locks and keys as required. Main circuit breakers shall be 100 percent amperage rated. Circuit breakers with frame ratings 800 amps and greater shall be electronic type with adjustable parameters and ground fault protection.

2.3 MAIN METERING DEVICE

- A. Provide a main meter device as shown or indicated on the Drawings.
 1. Microprocessor based monitoring device shall include complete electrical metering in one package. Device shall include self-contained potential transformers and self-protected internal fuses.
 2. Device shall be mounted on compartment door to allow operations and maintenance personnel access to meter menu and display.
 3. Device shall include trend analysis, event logging, and recording. Device shall also include the following direct-reading metered values:
 - a. Volts: 0.2 percent accuracy.

- b. Amperes: 0.2 percent accuracy
- c. Watts, Vars and VA: 0.5 percent accuracy
- d. Power Factor: 1.0 percent accuracy
- e. Frequency: 0.05 percent accuracy
- f. Watt, and VA Hours: 0.5 percent accuracy
- g. Var Hours: 1.0 percent accuracy
- h. Watt, Var and VA Demand: 0.4 percent accuracy
- i. THD-Voltage: 50th harmonic
- j. THD-Current: 50th harmonic
- k. Individual Ampere Harmonics: 50th harmonic
- l. Individual Voltage Harmonics: 50th harmonic
- 4. Metering device shall have the following additional features:
 - a. Trend analysis that displays minimum and maximum values for each metered parameter with date and time of each occurrence.
 - b. Input range of device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential transformers from a ratio of 120:120 to 500,000:120. Three current transformers suitably rated shall be included.
 - c. Alarm contacts rated five amps at 120 VAC.
 - d. Three analog outputs programmable to reflect the metered parameters, except kilowatt hours and kilovar hours.
 - e. Communication capability, using RS-485, Modbus RTU Protocol.
- 5. Control power shall be drawn from monitored incoming AC line. Device shall have non-volatile memory and not require battery backup. During power failure, device shall retain preset parameters.

2.4 SURGE PROTECTIVE DEVICES

- A. Provide a surge protective device in accordance with Section 26 43 00, Surge Protective Devices, for each motor control center bus shown on the Drawings. Surge protective devices shall be included and factory-mounted within the motor control center by motor control center manufacturer. Surge protective device monitoring and display shall be visible from the motor control center front.

2.4 SOURCE QUALITY CONTROL

- A. Prior to shipping, perform factory tests on motor control centers. Tests shall include manufacturer's standard tests and the following:
 - 1. Physical inspection and checking of components.
 - 2. Mechanical operation and device functionality tests.
 - 3. Primary, control, and secondary wiring hi-pot tests.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install materials and equipment at locations shown or indicated on the Drawings. Install equipment on concrete bases in accordance with the Contract Documents and manufacturer's recommendations and instructions.
- B. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between motor control center and wall for corrosion protection. Trim board neatly within outline of motor control center.
- C. Openings in top or side of motor control centers for other than conduit entrance are not allowed.
- D. Bundle cable circuits together within enclosures and identify with durable tag secured to cabling twine.
- E. Set motor circuit protectors at lowest setting that allows motor starting without nuisance tripping.
- F. Verify that wiring diagrams on inside of door of each compartment reflect the circuitry actually provided and that correct overload heater size and motor circuit protector setting are noted.
- G. Install in conformance with manufacturer's recommendations, Laws and Regulations, and the Contract Documents.
- H. Connections to existing facilities shall be in accordance with Section 01 14 16, Coordination with Owner's Operations.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Perform field testing and inspection of motor control centers. Inspect and test each motor control center after installation. Testing and inspection shall be in accordance with the manufacturer's recommendations and the Contract Documents, and be performed by manufacturer's factory-trained representative, Inform OWNER and ENGINEER when equipment is correctly installed, prior to testing. Do not energize equipment without permission of OWNER.
 - 2. Test Equipment, Calibration and Reporting: All test equipment, instrument calibration and test reports shall be in accordance with ANSI/NETA ATS.
 - 3. Perform the following minimum tests and checks before energizing equipment:
 - a. Verify all overload and device settings.

- b. Inspect mechanical and electrical interlocks and controls for proper operation.
- c. Check tightness of bolted connections.
- d. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
- e. Measure insulation resistance of each starter, phase-to-phase and phase-to-ground.
- f. Measure insulation resistance of each control circuit with respect to ground.
- g. Perform other tests recommended by equipment manufacturer.
- 4. Perform acceptance testing of motor control centers. Inspect and test each motor control center. Testing and inspection shall be performed by the independent testing firm, after completion of field testing specified in Paragraph 3.3.A.3 of this Section.
 - a. Visual and Mechanical Inspection: Perform inspection of each motor control center in accordance with ANSI/NETA ATS. Inspection shall include:
 - 1) Inspect for proper anchorage, damage, and grounding.
 - 2) Verify all overload and device settings.
 - 3) Check tightness of bolted connections.
 - 2. Electrical Tests: Perform electrical testing of each motor control center in accordance with ANSI/NETA ATS. Testing shall include:
 - 1) Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
 - 2) Measure insulation resistance of each starter phase-to-phase and phase-to-ground.
 - 3) Measure insulation resistance of each control circuit with respect to ground.
 - 4) Test motor overload units by current injection.
 - 5) Perform operational tests by initiating control devices for proper operation.
 - 6) Perform contact resistance test and insulation resistance test for each circuit breaker.
 - 7) Determine long-time, short-time, and instantaneous pick-up and delay as required.
- B. Manufacturer's Services: Provide a qualified, factory trained serviceman to perform the following:
 - 1. Supervise unloading and installation of equipment.
 - 2. Instruct CONTRACTOR in installing equipment.
 - 3. Inspect, test, and adjust equipment after installation and ensure proper operation.
 - 4. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
 - 5. Manufacturer's technician shall make visits to the Site as follows:
 - a. First visit shall be for supervising unloading and handling of equipment and for instructing CONTRACTOR in proper equipment installation, and

- assisting in installing equipment. Technician shall train installing personnel in advance in proper handling and rigging of equipment. Minimum number of hours on-Site: 8 hours.
- b. Second visit shall be for checking completed installation, start-up of system; and performing field quality control testing. Technician shall test the system as specified in Article 3.3.A of this Section. Technician shall operate and test the system in the presence of ENGINEER and verify that equipment complies with the Contract Documents and manufacturer's requirements. Technician shall adjust the system to initial settings as specified in Article 3.4 of this Section. Minimum number of hours on-Site 8 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
 - e. Furnish services of manufacturer's factory-trained service technicians to correct defective Work within 72 hours of notification by OWNER during the correction period.
5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 ADJUSTING

- A. Calibrate, set, and program all protective devices. Coordinate protective devices furnished under this Section and provide proper settings of devices in accordance with the study performed under Section 26 05 73, Electrical Power Distribution System Studies.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 27 26.13

LOW-VOLTAGE RECEPTACLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage receptacles.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 05 33.36, Outlet Boxes.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 498, Standard for Attachment Plugs and Receptacles.
 - 2. UL 514D, Cover Plates for Flush-Mounted Wiring Devices.
 - 3. UL 943, Standard for Ground-Fault Circuit-Interrupters.
 - 4. UL 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
 - 5. UL 1449, Standard for Surge Protective Devices.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 406, Receptacles, Cord Connectors, and Attachment Plugs (Caps).

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data: Manufacturer's technical information for receptacles and cover plates proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Receptacles:

1. Grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, ivory color.
 - a. Single:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5361I by Hubbell, Inc.
 - b) 5361-I by Pass & Seymour.
 - c) Or equal.
 - b. Duplex:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5362I by Hubbell, Inc.
 - b) PS5362-I by Pass & Seymour.
 - c) Or equal.
 - c. Weather-resistant Duplex:
 - 1) UL-listed as weather-resistant.
 - 2) Products and Manufacturers: Provide one of the following:
 - a) HBL5362IWR by Hubbell, Inc.
 - b) WR5362-I by Pass & Seymour.
 - c) Or equal.
2. Corrosion-resistant grounding receptacle, two-pole, three-wire, yellow color.
 - a. Single, 125-volt, 20 ampere, NEMA 5-20R configuration:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL53CM61 by Hubbell, Inc.
 - b) CR6301 by Pass & Seymour.
 - c) Or equal.
 - b. Duplex, 125-volt, 20 ampere, NEMA 5-20R configuration:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL53CM62 by Hubbell, Inc.
 - b) CR6300 by Pass & Seymour.
 - c) Or equal.
 - c. Single, 125-volt, 30 ampere, NEMA 5-30 configuration:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL9308 by Hubbell, Inc.
 - b) 3802 by Pass & Seymour.
 - c) Or equal.
3. Grounding receptacle, two-pole, three-wire, 250-volt, 20 ampere, NEMA 6-20 configuration, brown color.
 - a. Single:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5461 by Hubbell, Inc.
 - b) 5871 by Pass & Seymour.
 - c) Or equal.
 - b. Duplex:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5462 by Hubbell, Inc.
 - b) 5862 by Pass & Seymour.
 - c) Or equal.

4. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover where shown on the Drawings as “WP” or “WPU”, and provide where receptacles are located in wet or corrosive location.
 5. Receptacles shall comply with UL 498.
- B. Receptacles for Hazardous Locations:
1. Material: Factory-sealed receptacle suitable for installation in Class I, Group D hazardous locations. Copper-free aluminum receptacle and cover with cast gray iron alloy or cast malleable iron mounting box with zinc electroplate finish. Receptacle rated at 20 amperes, 125 to 250 volts AC, two-wire, and three-pole. Provide matching plug for each receptacle.
 2. Receptacles for hazardous locations shall conform to UL 1010.
 3. Products and Manufacturers: Provide one of the following:
 - a. Series CPS by Crouse-Hinds Company.
 - b. Type CPS by Appleton Electric Company.
 - c. Or equal.
- C. Ground Fault Interrupting Receptacles:
1. Duplex grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, 125-volt AC, 20 amperes, gray color with ground fault circuit interrupting (GFCI) protection.
 2. Ground fault interrupting receptacles shall comply with UL 943.
 3. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover where shown on the Drawings as “WP” or “WPU”, and provide where located in wet or corrosive location.
 4. Products and Manufacturers: Provide one of the following:
 - a. GFR5362SGY by Hubbell, Inc.
 - b. 2091-GRY by Pass & Seymour.
 - c. Or equal.
 5. Weather-resistant Ground Fault Interrupting Receptacles
 - a. Products and Manufacturers: Provide one of the following:
 - 1) 2095TRWRGRY by Pass & Seymour.
 - 2) Or equal.
- D. Weatherproof Covers:
1. Where receptacles are installed in damp locations as defined in area classification portion of Section 26 05 05, General Provisions for Electrical Systems, provide receptacles as specified in Paragraphs 2.1.A through 2.1.D of this Section, as applicable, with weatherproof covers as specified below.
 2. Provide covers that are UL-listed weatherproof and suitable for use in damp locations in accordance with NEC 406.
 3. Material:
 - a. Gasketed spring door type for wet and corrosive locations. Plates in corrosive locations shall have factory-applied 40-mil PVC coating.
 - b. Stainless steel screws and hardware.
 4. Products and Manufacturers: Provide one of the following:
 - a. Hubbell, Inc.

- b. Crouse-Hinds Company.
 - c. Appleton Electric Company.
 - d. Or equal.
- E. Weatherproof-While-in-Use Covers:
- 1. Where receptacles are shown on the Drawings as “WP” or “WPU”, and where receptacles are installed in wet locations as defined in area classification portion of Section 26 05 05, General Provisions for Electrical Systems, provide receptacles as specified in Paragraphs 2.1.A through 2.1.D of this Section, as applicable, with weatherproof-while-in-use covers as specified below.
 - 2. Provide covers that are UL-listed, weatherproof while receptacle is in use, and are of ultraviolet-resistant construction suitable for outdoor use in accordance with NEC 406.
 - 3. Material:
 - a. Non-metallic box with hinged, non-metallic cover.
 - b. Sealing gaskets between box and cover.
 - c. Stainless steel screws and hardware.
 - d. Color: Gray finish
 - 4. Products and Manufacturers: Provide one of the following:
 - a. TayMac Corporation.
 - b. Pass and Seymour Type WIU
 - c. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Non-hazardous Locations: Install receptacles at locations shown, in outlet or device boxes in accordance with Section 26 05 33.36, Outlet Boxes.
- B. Hazardous Locations: Install receptacles in rigid metallic conduit systems.
- C. Install receptacles with ground pole in the down position.
- D. Mount receptacles 18 inches above finished floor in non-hazardous locations and 4.5 feet above finished floor in hazardous locations, unless otherwise shown or indicated in the Contract Documents.
- E. Install in conformance with Laws and Regulations.

F. Identification:

1. Identify each conductor with circuit number and lighting panel number in accordance with Section 26 05 53, Identification for Electrical Systems.
2. Identify each receptacle with permanent phenolic tag. Tags shall include circuit number and lighting panel number.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 27 26.23

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install snap switches for lighting and other systems.

B. Related Sections:

1. Section 26 05 53, Identification for Electrical Systems
2. Section 26 05 33.36, Outlet Boxes.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. UL 20, General Use Snap Switches.
2. UL 894, Switches for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data: Manufacturer's technical information for switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches for Non-Hazardous Locations:

1. Single pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1221-I, by Harvey Hubbel, Inc.
 - 2) Catalog No. 1991-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC1-I, by Pass & Seymour
 - 4) Or equal.
2. Single pole, three-way AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1223-I, by Harvey Hubbell, Inc.

- 2) Catalog No. 1993-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC3-I, by Pass & Seymour
 - 4) Or equal.
 3. Two-pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1222-I, by Harvey Hubbel, Inc.
 - 2) Catalog No. 1992-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC2-I, by Pass & Seymour
 - 4) Or equal.
 4. Switches in non-hazardous areas shall be UL-listed in accordance with UL 20.
- B. Switches for Hazardous Locations:
1. Material: Factory sealed tumbler switch suitable for installation in Class I, Group D hazardous locations. Cast gray iron alloy or cast malleable iron body and cover with zinc electroplate finish. Switch rated at 20 amperes, 120/277-volt AC.
 2. Switches in hazardous areas shall be UL-listed in accordance with UL 894.
 3. Products and Manufacturers: Provide one of the following:
 - a. Series EDS by Crouse-Hinds Company.
 - b. Type EDS by Appleton Electric Company.
 - c. Or equal.
- C. Switch Covers:
1. Indoor covers shall be Type 304 stainless steel.
 2. Outdoor, wet, or corrosive location covers shall be weatherproof and corrosion resistant.
- D. Key Operated On-Off Switches:
1. Key operated switches shall be complete with legend plate and NEMA 4 enclosure and two keys for each switch.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switches at locations as shown or indicated in the Contract Documents in outlet or device boxes, in accordance with Section 26 05 33.36, Outlet Boxes.
- B. Mount wall switches 4.0 feet above finished floor unless otherwise noted.

- C. Identify each conductor with circuit number and lighting panel number. Identification shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 28 16.33

DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 27 26.23, Snap Switches.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 98, Enclosed and Dead-Front Switches.
 - 2. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 3. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC Article 404, Switches.
 - 2. Disconnect switches shall bear the UL label.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of each switch to be furnished, including location, rating, and NEMA enclosure type for each.
 - 2. Product Data:
 - a. Manufacturer's technical information for disconnect switches proposed for use.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
1. Square-D Company.
 2. Cutler-Hammer.
 3. General Electric Company.
 4. Siemens.
 5. Or equal.

2.2 MATERIALS

- A. Service Disconnect Switches:
1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in “OFF” position and safety handle.
 2. Rating: Voltage, current and short circuit ratings and number of poles as shown or indicated on the Drawings. Switch shall bear UL label indicating suitability for use as service equipment and shall comply with UL 98, NEMA KS 1, and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.
- B. Single Throw, Circuit Disconnect Switches:
1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in the "OFF" position and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label and shall comply with the requirements of UL 98, NEMA KS 1 and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position.
- C. Double Throw Safety Switches:
1. Type: Unfused, double throw with center “OFF” position, quick-make, quick-break mechanism, visible blades in the “OFF” position, and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for circuits being disconnected. Switches shall bear UL label and shall comply with UL 98, NEMA KS 1, and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.
- D. Disconnect Switches for 120-volt, Single-phase Circuits:
1. Refer to Section 26 27 26.23, Snap Switches.

- E. Enclosures: NEMA rating shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
- F. Identification:
 - 1. Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems.
 - 2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists. Mount disconnect enclosures at a height not exceeding six feet.
- C. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE++

SECTION 26 29 33

CONTROL STATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install control stations, including pushbuttons, selector switches, and other control stations elements.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before control stations Work.
- C. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 29, Hangers and Supports for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
 - 2. NEMA ICS 5, Industrial Control and Systems: Control-Circuits and Pilot Devices.
 - 3. NEMA ICS 6, Industrial Control and Systems Enclosures.
 - 4. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 5. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

- A. Component Supply and Compatibility:
 - 1. Obtain all control stations furnished under this Section from a single control station manufacturer.
 - 2. Components shall be suitable for the specified application and shall be integrated into the overall assembly by control station manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:

- a. Listing of control stations to be furnished with their location, rating, and NEMA enclosure type for each.
- 2. Product Data:
 - a. Manufacturer's technical information and specifications for control stations proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Control Stations:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Cutler-Hammer.
 - b. General Electric Company.
 - c. Allen Bradley Company.
 - d. Square-D Company.
 - e. Or equal.
 - 2. Type: 30.5 mm industrial, heavy duty, oil-tight construction with clearly-marked legend plates.
 - 3. Emergency Stop or Lockout Stop: Lockout stop pushbuttons shall be two-position, push-pull type with maintained contact and mushroom head. Provide control stations with padlocking attachment and legend plate reading "PUSH-TO-STOP, PULL-TO-START".
 - 4. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
 - 5. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both left and right to maintained position.
 - 6. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
 - 7. Indicating Lights: 120 vac LED module, push-to-test. Lens color shall be in accordance with Section 26 05 53, Identification for Electrical Systems.
 - 8. Enclosures: As required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems, and complying with NEMA 250 and NEMA ICS 6.
 - 9. Identification: Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems. Devices shall include front-mounted nameplates identifying function and equipment controlled, if not readily apparent.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER

in writing of conditions detrimental to proper and timely completion of the Work.
Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install equipment as shown and indicated, and provide sufficient access and working space for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports where no wall or other surface exists, in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 16425

VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install variable frequency drives, complete and operational. VFDs shall be furnished by the Pump Manufacturer who shall assume full responsibility for coordination of the VFD with the pumping equipment.
2. Variable frequency drives required under this Section are low-voltage, voltage source inverter, pulse width modulated. Variable frequency drives shall be customized.
3. Variable frequency drives shall communicate with the Main Control Panel (MCP) via Modbus and hardwired connections.
4. Variable frequency drives included in this Section are associated with the following equipment:
 - a. High Capacity Pumps
 - b. Low Capacity Pumps
5. Motor Protection Relay furnished under Section 43 21 39.13 shall be installed in the VFD panel. Coordinate with Section 43 21 39.13 for the installation of the Motor Protection Relay within the VFD panel.

- B. Variable frequency drives are specified in this Section but are provided as part of an overall system package by the driven equipment supplier. The equipment supplier shall have overall system responsibility for variable frequency drives as specified in this Section and shall be responsible for coordination of the overall variable speed drive system with the relevant process equipment application. This shall include coordination of the equipment and motors with the variable frequency drive units, as well as coordination of the drive system interfacing with electrical work and instrumentation and controls specified in Division 40 and Division 26. Overall system responsibility shall include field testing, start-up, training, calibration and overall successful operation of the equipment.

C. Related Sections:

1. Section 43 21 39.13, Submersible End Suction Pumps.
2. Section 40 06 05, Instrumentation and Control for Process Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

2. NEMA AB 1, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
3. NEMA ICS 2, Industrial Control and Systems, Controllers, Contactors and Overload Relays Rated 600 Volts.
4. NEMA ICS 7, Industrial Control and Systems Adjustable Speed Drives.
5. NEMA MG 1, Motor and Generator Standard.
6. UL 508, Industrial Control Equipment.
7. ISO 9000, Quality Management Systems, Fundamentals and Vocabulary.
8. ISO 9001, Quality Management Systems, Requirements.
9. ISO 9002, Quality Systems, Model for Quality Assurance in Production, Installation and Servicing.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Variable frequency drive manufacturer shall have at least five years of experience designing and regularly manufacturing and servicing substantially similar equipment to that specified, and shall submit documentation upon request of at least five installations in satisfactory operation for at least five years.
 - b. Manufacturer shall be certified under ISO 9000, ISO 9001, or ISO 9002 for materials and equipment specified.
 - c. For all required factory tests, variable frequency drive manufacturer shall use a factory test facility that has calibrated its testing apparatus in the previous twelve months, and is staffed by qualified, experienced technicians.

B. Component Supply and Compatibility:

1. Drives specified under this Section employ a low switching frequency or pattern to minimize instantaneous rate of voltage change over time (dv/dt), and the adverse effects of potential bearing currents. Where alternate manufacturers are proposed, obtain manufacturer recommendations regarding bearing currents and provide equipment required at no additional cost to OWNER.
2. Each variable frequency drive shall be totally compatible with associated driven equipment and motors. Variable frequency drives shall be matched to specific load requirements for each system. Operation of variable frequency drive shall not overstress motor insulation.
3. To centralize responsibility and to ensure that all equipment is properly coordinated, variable drives specified under this Section shall be obtained from the Supplier of the associated driven equipment.
4. Similar components of drives associated with each system shall be products of a single manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Dimensional information and construction details of enclosures. Enclosure details shall consist of exterior and interior front door with nameplate legends, interior door front and rear views, and terminal block layout.
 - b. Three-line power and control schematic diagrams.
 - c. Wiring diagrams showing the interconnection of conductors to all devices with terminal assignments for remote devices.
 - d. Functional description of system operation.
 - e. VFD heat dissipation at full load, including heat rejection/cooling system.
 2. Product Data:
 - a. Technical specifications.
 - b. Catalog cuts and product literature.
 3. Testing Plans:
 - a. At least thirty days prior to source quality control testing, submit descriptions of proposed shop testing methods, procedures, and apparatus.
 - b. At least thirty days prior to field quality control testing, submit descriptions of proposed field testing methods, procedures, and apparatus.
- B. Informational Submittals: Submit the following:
1. Certificates:
 - a. Certification letters from variable frequency drive manufacturer and motor manufacturer that the approved driven equipment has been reviewed and that variable frequency drive units and motors are compatible, and shall be provided in accordance with the Contract Documents and requirements of the driven equipment.
 2. Source Quality Control Submittals:
 - a. Within five days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
 3. Field Quality Control Submittals:
 - a. Within five days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
 4. Manufacturer Reports:
 - a. Within five days of each visit to the Site by manufacturer's representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.
 5. Qualifications Statements:
 - a. Manufacturer, when requested by ENGINEER.
 6. List of spare parts recommended by the manufacturer. The list shall describe each part, the quantity recommended and unit price of each part.
- C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, list of recommended spare parts, and spare parts ordering information.

- b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices to be embedded in cast-in-place concrete in ample time to prevent delaying the Work.
2. Shipping containers shall be designed to be shipped by truck, rail, or ship. Indoor containers shall be bolted to skids.
3. Inspect variable frequency drive equipment for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.

B. Handling:

1. Lift, roll or jack variable frequency drive equipment into locations shown.
2. Variable frequency drives shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer's requirements.

C. Storage:

1. Store variable frequency drive equipment in a clean, dry location with controlled, uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. System Performance:

1. Driven equipment to be controlled by a variable frequency drive shall be provided with a customized variable frequency drive. Each drive unit shall include an adjustable frequency controller with associated controls for continuous speed adjustment and protection of the driven equipment. Output speed control of motor shall be continuous throughout speed range of two to 60 Hertz under variable torque load or constant torque as specified for the driven equipment.
2. Variable frequency drives associated with each set of driven equipment shall be similar to each other.
3. Variable frequency drives shall be UL-listed or ETL-listed and designed, built, and tested in accordance with NEMA AB 1, NEMA ICS 2, NEMA ICS 7, and UL 508.

2.2 MANUFACTURERS

- A. Provide variable frequency drives by one of the following:

1. ABB
2. Eaton
3. Square D
4. Or equal

2.3 ENCLOSURE

- A. Provide each variable frequency drive with freestanding, front-access, NEMA 1, filtered and gasketed enclosure. Enclosure shall house all components required for the associated variable frequency drive.
- B. Enclosure shall provide adequate cooling for components within and include positive ventilation.
- C. Enclosure shall include circuit breaker disconnect switch. Circuit breakers shall be in accordance with NEMA AB 1. Switch handle shall be suitable for padlocking and be through-the-door type with handle height not exceeding six feet. Operation of switch shall remove the service supply from all internal components. Power devices shall be suitable for interrupting capacity of 65,000 RMS symmetrical amperes. Include current limiting semi-conductor fuses where required for protection of solid state components.
- D. Enclosure door shall include an operator interface for access to controller's digital keypad and display.
- E. Equipment enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 16075, Electrical Identification.
- F. Equipment enclosure with phenolic type terminal blocks suitably labeled for all internal and remote wiring requirements, plus twenty percent spare.

2.4 ADJUSTABLE FREQUENCY CONTROLLER

- A. General:
 1. Adjustable frequency controller shall be microprocessor-based, pulse width modulated design, suitable for operation on a 480-volt, three-phase supply. Controller shall produce an adjustable AC voltage/frequency output to vary speed of driven equipment. Controller shall consist of the following sections:
 - a. Six pulse diode bridge converter input section for Low Capacity Pumps
 - b. An input phase shifting transformer and an 18 pulse converter section. For High Capacity Pumps. Fixed DC bus section.
 - c. Six pulse power transistor inverter output section for Low Capacity Pumps.
 - d. Power transistor inverter output section for High Capacity Pumps.
 2. Controller switching frequency shall be adjustable and allow operation at 5,000 Hertz or less. Controller technology shall include a switching scheme that reduces the dv/dt of output supply.

3. Equip controller with a three-percent DC bus reactor or input line reactor.
4. Controller's solid state converter input section switching devices shall have 1600 volt PIV rating.
5. Overload rating of 110 percent variable torque, 150 percent constant torque for one minute.
6. RMS harmonic content of output current shall be less than five percent of fundamental current.
7. Able to withstand output terminal line-to-line short circuits without component failure.

B. Operating Criteria:

1. Operating criteria shall be in accordance with the following:
 - a. Ambient temperature range of zero to 40 degrees C.
 - b. Operational humidity of up to 90 percent non-condensing.
 - c. Altitude up to 3,300 feet above sea level.
 - d. Nominal voltage of 480-volts plus or minus ten percent, three-phase, three-wire. Include an under-voltage feature to allow trip-free operation down to 35 percent undervoltage.
 - e. Nominal frequency of 60 Hertz plus or minus three Hertz.
 - f. Input power factor of 95 percent displacement power factor at all operating speeds.
 - g. Efficiency of 96 percent at full speed and full load.

C. Features:

1. Controller shall have the following features:
 - a. Digital keypad and display module shall provide parameter setting, adjustments, and monitoring of control functions and faults. Display messages shall be in English.
 - b. Serial communication port shall provide laptop interface using manufacturer standard protocol.
 - c. Independent acceleration/deceleration rates shall provide two to 600 seconds minimum. When called to stop, motor shall decelerate to minimum speed before stopping.
 - d. Power loss feature shall allow five cycle ride through capability for input supply interruptions.
 - e. Time delay automatic restart shall allow restart after controller fault conditions with programmable attempts.
 - f. Coasting motor restart shall allow controller to restart into a coasting motor without damage or tripping. Coasting motor restart feature shall allow switching from bypass mode to variable frequency drive mode while operating, without shutdown.
 - g. Isolated control inputs and outputs.

D. Protection:

1. Controller shall have protective functions as follows:
 - a. Input line metal oxide varistor transient protection.
 - b. Electronic over-current trip instantaneous and inverse time overload protection with thermal memory retention.

- c. Over-temperature trip temperature protection.
- d. Current limit trip protection.
- e. Input line over- and under-voltage trip protection.
- f. Ground fault trip protection.

E. Communication:

- 1. Provide Modbus communication to the MCP as follows:
 - a. Provide Modbus communication option and module for Ethernet connection to the MCP.
 - b. Configure the drive to provide all the signals to and from the MCP as shown and specified on the P&IDs and in the Project Input/Output Point List, including all alarm and interlock signals.
 - c. Configure the IP address of the drive in coordination with the OWNER's network.

2.5 OUTPUT FILTER

A. General:

- 1. Provide output filter to prevent overstressing motor insulation system. Provide output filter with each variable frequency drive, when cable length between motor and variable frequency drive exceeds the following based on noted switching frequencies.
 - a. One KHZ switching frequency, 200 feet cable length.
 - b. Three KHZ switching frequency, 175 feet cable length.
- 2. Provide output filters in all other cases, based on recommendations of variable frequency drive and motor manufacturers, when actual voltage peaks at motor terminals exceed NEMA MG 1 limits.

B. Features and Criteria:

- 1. Filter shall be three-phase, 600-volt class motor-protecting type consisting of suitable values of inductance, capacitance and resistance to form a damped, low pass filter.
- 2. Filter shall be low-loss type specifically designed to reduce voltage wave form dv/dt . Filter shall allow cable lengths at minimum exceeding actual application distances with waveform resulting in voltage spikes at motor terminal that are within NEMA MG 1 Part 31 voltage stress levels.
- 3. Filter shall be suitable for mounting within variable frequency drive enclosure.

2.6 BYPASS CIRCUIT

A. General:

- 1. Provide each variable frequency drive with contactor bypass capability (except for the bar rack and fine screens). Mount bypass equipment within variable frequency drive enclosure.
- 2. Bypass configuration shall consist of output and bypass contactors, and line side isolation circuit breaker.

3. Bypass arrangement shall allow full speed operation of driven equipment while maintaining complete isolation of adjustable frequency controller for the HVAC fans and the fine screens
4. Bypass arrangement for influent pumps and Biofilter fans shall utilized Reduced Voltage Solid-State Starter:
 - a. General:
 - 1) Provide solid-state, step-less, current limiting, soft-start, motor controllers (RVSS).
 - 2) RVSS shall be three-phase type and shall include an overload relay and isolation contactor.
 - 3) Provide subsystems that will protect RVSS from damage due to over-current and over-voltage.
 - 4) Current Rating: 115 percent of motor nameplate rated current, continuous, minimum.
 - b. Required Features:
 - 1) Adjustable current limit of not more than 250 percent of motor nameplate full-load current throughout entire motor acceleration period including first three cycles of voltage waveform from instant start signal is engaged.
 - 2) Adjustable voltage acceleration, from two to 30 seconds.
 - 3) Adjustable voltage deceleration, from two to 30 seconds.
 - 4) Phase loss detection.
 - 5) LED diagnostic indicators.
 - 6) Static over-current and over-voltage trip.
 - 7) Phase reversal, line or fuse loss, and under-voltage protection.
 - 8) Power unit over temperature protection.
 - 9) Motor inverse time overload protection.
 - 10) Input line transient over-voltage protection.
 - c. On start-up, start driven equipment at zero current and allow driven equipment to accelerate to maximum speed without exceeding the set current limit.
 - d. On normal shutdowns, ramp driven equipment down at set deceleration rate that is non-regenerative for motor prior to shutdown.
 - e. On emergency shutdowns, remove power to motor.
 - f. Diagnostic LEDs: Provide LEDs on unit front that indicate the following:
 - 1) Control power on.
 - 2) Motor power on.
 - 3) Motor starting.
 - 4) Motor fault.
 - 5) RVSS fault.
 - g. Control Outputs:
 - 1) Control output shall be electrically isolated, dry, normally open SPDT contacts, rated 10 amps at 120 VAC.
 - 2) Provide the following control outputs for remote indication:
 - i. BYPASS RUN (Bypass motor running).
 - ii. BYPASS FAULT (Motor fault or RVSS fault).
5. Bypass circuit devices shall be in accordance with NEMA ICS 2.

B. Contactors:

1. Contactors shall be single speed full voltage, electrically operated, 600-volt, three-pole, industrial duty with ampere ratings as required for driven equipment.
2. Contactors shall have removable main contacts, 120-volt magnetic coil and interlocking contacts. Arrange interlocking contacts to prevent output and bypass contactors from being closed at the same time.
3. Bypass contactor shall include a variable frequency drive/bypass selector switch and associated controls for manual selection of operating mode. Bypass contactor shall include transfer timer to provide an adjustable off delay when switching from variable frequency drive to bypass.

C. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with the following:

1. Electronic Overload Relays: Relays shall be electronic type. Electronic relays shall be multi-function, adjustable, current sensing, type, and include overload, phase-unbalance, phase-loss, and equipment type ground fault in one package.
2. Each overload relay shall be manual reset type and shall include provisions for resetting by an insulating button on front of starter unit door.
3. Each overload relay shall include a normally open auxiliary contact for remote alarm purposes.
4. Each overload relay shall be sized for full-load amperes and service factor of actual motors installed.

2.7 CONTROLS

A. General:

1. Equip each variable frequency drive control system with relays, switches, fuses, indicating lights, and components required for a complete, functional system.
2. Variable frequency drive control shall be powered from a suitably sized and protected control power transformer.
3. Variable frequency drive control shall include status indicators, controller, and system fault condition displays and operating controls. Provide status indicators and operating controls associated with drive control on front door of enclosure.
4. Control arrangement shall be such that variable frequency drive internal electronic supply voltage is isolated from field wiring.

B. Control and Pilot Devices:

1. Relays shall be standard, latching type, and pneumatic or solid state time delay type. Provide relays with contacts rated ten amps, quantity as required.
2. Pilot devices shall be heavy duty type, rated 10 amps continuous. Indicating lights shall be push-to-test transformer type with 12-volt secondary's.
3. VFD manufacturer shall install motor protection relay furnished by the pump manufacturer in the VFD enclosures as specified in Section 43 21 39.13 Submersible End Suction Pumps. Contractor shall coordinate the requirements of the motor protection relay with both pump and VFD manufacturers. Provide power supply or transformer as required to power the motor protection relay. Motor protection relay shall provide for motor shut down and shall include a remote reset located at the VFD.

C. Operation:

1. Controls for the variable frequency drives High Capacity and Low Capacity pumps shall consist of all devices necessary for the following:
 - a. Stop/Start and Speed: Stop/start and speed control shall respond to drive-mounted selector switch. With switch in "REMOTE" position, stop/start and speed control shall be from remote contact and remote 4-20mA signal from a remote control panel. With switch in "LOCAL" position, stop/start control shall be based on remote stop/start pushbuttons located on the VFD. The speed shall be controlled from the VFD's drive-mounted speed potentiometer.
 - b. Emergency Stop Control: Emergency stop control shall respond to remote stop pushbutton located adjacent to driven equipment and to remote stop pushbutton located at VFD. When activated, driven equipment shall stop immediately in all operating modes. Emergency stop circuit shall be powered from a separate 24 volt control power transformer to prevent shorting out of emergency stop signal shutting the motor off in the event of flooding in the drywell. Configure control of emergency stop accordingly.
 - c. Low Flow switch: VFD shall respond to a remote discharge flow switch. When low flow is detected, driven equipment shall stop after an adjustable time delay.
 - d. Level A Alarm (Critical): Motor shall shut down on the conditions from a signal from relay module, provided under by the pump manufacturer, turned over to the VFD manufacturer and installed in the VFD. All provisions, 120 volt wiring, control wiring for module inside the VFD shall be provided by the VFD manufacturer. Refer to specification 43 21 39 for additional control and mounting requirements and other details of module associated with the pumps.

D. Auxiliary Features:

1. Provide each variable frequency drive with the following:
 - a. Status Indicators: Status indicators shall include separate pilot lights for indication of motor run (red), and bypass mode (blue).
 - b. Shutdown Indicators: Shutdown indicators shall include separate pilot lights (amber) for each shutdown condition. Arrange shutdown indication circuitry so that, when activated, indicator and restarting of the drives requires manual reset.
 - c. Contact Outputs: Contact outputs shall include separate dry contacts for remote indication of motor run, motor overload, each shutdown condition including E-stop, controller faults and in bypass mode.
 - d. Speed Output: Speed output for remote indication of motor speed shall be hardwired based on a 4-20ma signal from the VFD.
 - e. Remote speed control shall be hardwired from the equipments associated control panel.
 - f. Remote start/stop shall be hardwired from the equipments associated control panel.

- g. Low flow switch and remote estop shall be wired in the VFD with a separate CPT such that if the instruments become submerged and short circuited the VFD will continue to run. Control voltage shall be 24 Vac.
- E. Wiring and Device Identification:
 - 1. Provide control wiring and device identification for each variable frequency drive:
 - a. Identify all control conductors with permanent type wire markers. Each wire shall be identified by a unique number and shall be attached to wire at each termination point.
 - b. Identify each control device with permanent type marker. Each device shall be identified by a unique number and shall be attached to each device.
 - c. Numbering system for each wire and control device shall be identified on wiring diagrams and shall reflect actual designations used in the Work.

2.8 SOURCE QUALITY CONTROL

- A. Tests:
 - 1. Perform factory tests on each variable frequency drive prior to shipping. Test shall consist of simulating expected load to be driven by operating load through speed ranges specified for driven equipment, for minimum of two hours per drive unit.
 - 2. Provide factory control and alarm tests on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
 - 3. Perform specified tests in addition to standard factory tests typically performed.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations and instructions and in conformance with Laws and Regulations, and the Contract Documents.
- B. Unless otherwise shown or indicated, install equipment on concrete bases.
- C. Install equipment with sufficient access and working space provided for ready and safe operation and maintenance.

- D. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between equipment and wall for corrosion protection. Trim board neatly within outline of equipment.
- E. Install all terminations, lugs, and required appurtenances necessary to properly terminate power supplies.
- F. Install control wiring terminations and appurtenances necessary to complete installing control and monitoring devices.

3.3 FIELD QUALITY CONTROL

A. Site Tests:

- 1. After installation, inspect, adjust, and test each variable frequency drive at the Site. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Through CONTRACTOR, manufacturer's factory-trained representative shall inform OWNER and ENGINEER when equipment is correctly installed and ready to be energized. Do not energize equipment without permission of OWNER.
- 2. Perform the following equipment inspection and testing and provide reports documenting procedures and results.
 - a. Verify all device settings and drive adjustments.
 - b. Inspect all mechanical and electrical interlocks and controls for proper operation.
 - c. Test each drive through specified speed ranges and loads for a minimum of two hours per drive unit.
 - d. Test each drive by using actual control signal for remote and local operation.
 - e. Test each drive alarm function.
 - f. Perform other tests recommended by equipment manufacturer.

B. Manufacturer Services:

- 1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of equipment and installation at equipment's final location. Representative shall train installing personnel in advance in the proper handling and rigging of equipment. Services by manufacturer's representative under this paragraph shall be at least one eight-hour days at the Site.
- 2. Post-installation Check: Manufacturer's factory-trained representative shall check and approve the installed equipment before initial operation. Manufacturer shall calibrate, set and program variable frequency drives provided. Services by manufacturer's representative under this paragraph shall be at least one eight-hour days at the Site.
- 3. Manufacturer's factory-trained representative shall adjust the system to final settings as specified in Paragraph 3.5 of this Section.
- 4. Manufacturer's factory-trained representative shall test the system as specified in Paragraph 3.3.A of this Section. Representative shall operate and test the system in presence of ENGINEER and verify that equipment is in conformance

with the Contract Documents. Services by manufacturer's representative under this paragraph shall be at least one eight-hour days at the Site.

5. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
6. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
7. Replacement parts or equipment provided during the correction period shall be equal to or better than original.
8. Training: Provide services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment.

3.4 ADJUSTING

- A. Following Substantial Completion, when inspection and testing are complete and variable frequency drives are operating, manufacturer's representative shall return to the Site and make final adjustments as required to each variable frequency drive furnished under this Section.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 32 13

ENGINE GENERATOR SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Provide all labor, materials, equipment, and incidentals as shown specified and required to furnish and install standby power generator systems with appurtenances for complete and operational system.
2. The following generator systems are included in this Specification section:
 - a. One, 1800 rpm natural gas engine generator as follows:
 - 1) Rating: Minimum 550 kW, 0.8 power factor, 480/277 volt, 3 phase, 3 wire, 60 hertz when equipped with all necessary accessories. Set shall operate on natural gas. Set shall be rated for standby operation, without derating.
 - 2) Enclosure: Outdoor, Level 2 sound attenuated enclosure.

B. Coordination:

1. Review installation procedures under other Specification sections and coordinate the installation of items that must be installed with or before generator sets.
2. Coordination:
 - a. Review installation procedures under other Sections and coordinate the installation of items that must be installed with or before the equipment that are addressed in this section.
 - b. Coordinate with the producer of the Section 26 05 73, Electrical Power Distribution System Studies for the following:
 - 1) Provide itemized lists of ratings and characteristics data pertinent to each specific item of equipment being proposed for use in this project for incorporating them into the studies.

C. Related Sections:

1. Section 26 05 73, Electrical Power Distribution System Studies.

1.2 REFERENCES

A. Standards referenced in this section are:

1. International Standards Organization (ISO), ISO 8528, Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets.
2. ISO 9001, International Quality Standard
3. NEMA MG1, Motors and Generators.
4. NFPA 30, Flammable and Combustible Liquids.

5. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
6. NFPA 70E, Electrical Safety in the Workplace.
7. NFPA 110, Standard for Emergency and Standby Power Systems.
8. UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
9. UL 508, Safety Standard for Industrial Control Equipment.
10. UL 1236, Battery Chargers.
11. UL 2200, Stationary Engine generator Assemblies (rated 600 volts or less).

1.3 QUALITY ASSURANCE

A. Supplier's Qualifications:

1. Supplier shall have a minimum of five years of experience of producing substantially similar equipment to that specified and shall document at least five installations in satisfactory operation for at least five years.
2. Supplier shall possess ISO 9001 certification.
3. Supplier's authorized distributor shall have complete parts and service facilities, factory-trained service staff available for 24-hour emergency service, 365 days per year, and be authorized to administer the warranty for all components of the standby generator systems.
4. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
5. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

B. Component Supply and Compatibility:

1. Obtain all equipment included in this Specification section regardless of the component supplier from a single generator set manufacturer. Materials, equipment, and parts shall be new, of current production of a firm that supplier the generator set as a matched system. Supplier shall have full responsibility for the performance of the generator sets and their accessories. Generator set supplier shall prepare all Shop Drawings and other submittals for all components furnished under this Section.
2. Generator sets shall be factory assembled. Factory test and verify in the factory that generator systems free from electrical and mechanical defects and that they conforms to the Contract Documents.

C. Regulatory Requirements: Comply with applicable provisions of regulatory agencies having jurisdiction:

1. 40 CFR Part 89, Control of Emissions from New and In-Use Nonroad Compression Ignition Engines, Subpart D Emission Test Equipment Provisions

2. Local Ordinances: The generator sets shall meet local requirements relative to noise control and emissions.
3. Local and State Building Codes: Installations shall meet applicable codes including requirements of local fire marshals.
4. Permits: Contractor shall obtain and pay for required permits, fees, and inspections by authorities having jurisdiction

1.4 SUBMITTALS

- A. Shop Drawings: Submit the following:
 1. Bill of material for all equipment and spare parts.
 2. Supplier's qualifications.
 3. Warranty certificates.
 4. Supplier's literature, specifications, engineering data sheets, drawings, and installation, testing, and startup instructions necessary to fully describe the generator sets and appurtenances, and substantiate compliance with the Contract Documents. Information shall be annotated to clearly indicate ratings, features, and options specific to the Project.
 5. Generator set data for each system shall include:
 - a. Listed to UL 2200.
 - b. Heat rejection to room
 - c. Combustion air requirements.
 - d. Electrical wiring and interconnection diagrams with all external connections identified.
 - e. Factory painting specifications.
 - f. Calculations verifying Generator's size.
 6. Engine data shall include:
 - a. Fuel flow at rated load.
 - b. Fuel consumption at 1/4, 1/2, 3/4, and full load.
 - c. Engine Type: Naturally aspirated or turbocharged and after-cooled.
 - d. Maximum exhaust backpressure.
 - e. Silencer attenuation rating.
 - f. Jacket water heater system.
 - g. Gaseous emissions data measurements for hydrocarbons, carbon monoxide, particulate matter, and NOx conforming to 40 CFR 89, Subpart D.
 7. Alternator data shall include:
 - a. Winding insulation class and temperature rise per NEMA MG-1- 1.65
 - b. Standby and continuous kW/kVA ratings.
 - c. Motor starting kVA at 90 percent sustained voltage.
 - d. Surge kW capacity.
 - e. Machine reactances and time constants.
 8. Starting system data shall include:
 - a. Battery system
 - b. Battery charger.
 - c. Cycle cranking configuration.

9. Control panel data shall include:
 - a. Description of control features.
 - b. Operator panel control switches and functions.
 - c. Alarm and status displays.
 - d. Provisions for remote start signal and remote status and alarm.
 - e. Compliance with UL 508.
10. Enclosure data shall include the following:
 - a. Plan and elevation drawings showing overall dimensions, interior equipment arrangement, and working spaces.
 - b. Construction details and hardware specifications.
 - c. Exhaust piping and silencer mounting arrangement.
 - d. Sound attenuation provisions and decibel levels.
11. Provide the following relative to installation requirements:
 - a. Vibration isolators and anchor bolt requirements.
 - b. Unloading and rigging requirements.
12. Circuit Breaker:
 - a. Circuit Breaker time over current characteristic curves and the alternator thermal damage curves, demonstrating the effectiveness of the protection provided.

B. Quality Assurance/Quality Control Submittals:

1. Testing and startup submittals shall include:
 - a. Prototype testing certification.
 - b. Field testing procedures and services to be performed by supplier's representative, provided at least thirty days prior to testing
 - c. Start-up procedures and services to be performed by supplier's representative.
 - d. Field service reports by supplier's representative for each visit to the Site.

C. Closeout Submittals:

1. Operation and Maintenance Manuals: Include the following information:
 - a. Operating Instructions: Instructions for starting, stopping, protection of circuits, automatic controls, battery charging and safety considerations. Methods for adjusting speed, output voltage, and control timers.
 - b. Performance Parameters: Provide nominal values and acceptable limits for output voltage, frequency, load, engine temperature, and oil pressure. Include circuit drawings with component identifications for reference.
 - c. Maintenance Instructions: Procedures for daily, weekly, monthly, and annual basis, or on an hours-run basis. Include guidance for selection of natural gas, lubricating oil, use of water treatment additives, and anti-freeze.
 - d. Troubleshooting procedures.
 - e. List of recommended spare parts and maintenance materials.

1.5 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. Obligations of Contractor under the Contract Documents shall not be limited by provisions of the specified special warranty.
- B. Special Warranty:
 - 1. Provide supplier's written warranty, running to the benefit of Owner, agreeing to correct or, at option of Owner remove or replace materials or equipment specified in this Section found to be defective during a period of five years after date of Start Up.
 - 2. Products supplied under this Section shall be covered by a single warranty for the coverage period. Warranty shall provide for free replacement or repair of parts for five years of operation. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts, cost, etc.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
 - 1. Cover all generator air and exhaust openings with vapor inhibiting and water repellent material.
 - 2. Inspect equipment for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.
 - 3. Notify Engineer of loss or damage to equipment or components. Replace loss and repair damage to new condition per supplier's instructions
- B. Equipment shall be handled in accordance with supplier's instructions. One copy of these instructions shall be provided with equipment at time of shipment.
- C. Storage:
 - 1. Store equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls. No switchgear in this spec.
 - 2. Store materials for easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect equipment from corrosion and deterioration.

1.6 MAINTENANCE

- A. Spare Parts:
 - 1. Provide the following spare parts for each generator set:
 - a. One set of air filters.
 - b. Two control circuit fuses of each size used.

- c. Two sets of lube oil filters.
 - d. One set of fan belts.
 - 2. Spare parts shall be packed in sturdy containers with clear indelible identification markings and be stored in a dry, warm location until transferred to Owner.
- B. Planned Maintenance Agreement:
- 1. Provide one year planned maintenance agreement to be completed by a factory certified technician with semi-annual visits. The first visit will be for inspection and the second visit will be for a full service including changing the oil and oil filters. Inspection shall include the following:
 - a. Clean all battery terminals and verify integrity of cables and connectors.
 - b. Load test battery.
 - c. Measure specific gravity of each battery cell.
 - d. Check and record engine oil pressure and water temperature.
 - e. Test coolant freeze point and verify coolant level.
 - f. Verify and record output voltage and adjust voltage regulator if necessary.
 - g. Inspect and lubricate generator end bell bearing.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The number and ratings of the systems shall be as indicated in Paragraph 1.1.A.2. and as shown on the Drawings. Generators shall not be loaded more than 80% with voltage drop not exceeding 20% at any step. Size of Generator is based on Cummins/ONAN.
- B. Generators shall be rated for standby operation for the duration of a normal utility outage as defined by ISO 8528 for limited time operation.
- C. Generator assemblies shall be UL 2200 listed, control panels shall be UL 508 listed.
- D. Generators shall be rated for the specified kW, without overload, at the following Site conditions:
 - 1. Maximum Ambient Temperature: 50 degrees C.
 - 2. Altitude: 850 feet above sea level.
- E. Performance:
 - 1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.

2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
3. The engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Motor starting capability shall be a minimum of 400 kVA. The generator set shall be capable of sustaining a minimum of 90% or rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.
6. Note largest load is a 400HP VFD driven pump. Provide allocations in design of the system to accommodate this VFD load.

F. Construction:

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

G. Connections:

1. The generator set load connections shall be composed of tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at distribution panel (not supplied with generator).
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.2 SUPPLIERS

A. Provide generator systems of one of the following:

1. Cummins/ONAN
2. Caterpillar
3. Or equal.

2.3 ENGINE AND ENGINE EQUIPMENT

- A. The engine shall be natural gas fueled, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the

alternator and all connected accessories. Engine accessories and features shall include:

1. Complete engine fuel system, including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set.
2. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.
3. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H₂O external static head. Radiator shall be sized based on a core temperature that is 20°F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.
4. Electric starter(s) capable of three complete cranking cycles without overheating.
5. Positive displacement, mechanical, full pressure, lubrication oil pump.
6. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
7. Replaceable dry element air cleaner with restriction indicator.
8. Flexible fuel lines.
9. Engine mounted battery charging alternator, 40-ampere minimum and solid-state voltage regulator.
10. Coolant Heater: 208 Vac, 1500 watts minimum:
 - a. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. The coolant heater shall be UL499 listed and labeled.
 - b. The coolant heater shall be installed on the engine with high temperature silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
 - c. The coolant heater shall be provided with a 24 vdc thermostat with integral 120 vac-24 vdc transformer, installed at the engine thermostat

housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

- d. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
- 11. Provide alternator anti-condensation heater, 120 vac, 100 watts minimum.
- 12. Provide generator control anti-condensation heater 120 vac, 100 watts minimum.
- 13. Provide vibration isolators, pad type or as recommended by the manufacturer, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
- 14. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.
- 15. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
- 16. Provide a minimum 10 amp, 120 vac battery charger for each generator set battery bank. Charger enclosure shall be NEMA 3R if the charger is mounted within the generator enclosure or NEMA 4XSS Type 316 if mounted outside of the generator enclosure.

2.4 AC GENERATOR

- A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.
- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- D. The subtransient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.
- E. The alternator shall be capable of operation with reverse kVAR of 0.15 per unit.

2.5 GENERATOR SET CONTROL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The generator set mounted control shall include the following features and functions:
 - 1. Control Switches:
 - a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - b. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
 - c. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 - d. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
- D. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:
 - 1. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output kW, kW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
 - 2. Voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (kW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall indicate normal and abnormal operating condition. Metering accuracy shall be within 1% at rated output.

3. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
4. The control system shall log total number of operating hours, total kWh, and total control on hours, as well as total values since reset.

E. Generator Set Alarm and Status Display

1. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
 - a. The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).
 - b. The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
 - c. The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - d. The control shall include an amber common warning indication lamp.
2. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
 - a. low oil pressure (warning)
 - b. low oil pressure (shutdown)
 - c. oil pressure sender failure (warning)
 - d. low coolant temperature (warning)
 - e. high coolant temperature (warning)
 - f. high coolant temperature (shutdown)
 - g. high oil temperature (warning)
 - h. engine temperature sender failure (warning)
 - i. low coolant level (warning)
 - j. fail to crank (shutdown)
 - k. fail to start/over crank (shutdown)
 - l. over speed (shutdown)
 - m. low DC voltage (warning)
 - n. high DC voltage (warning)
 - o. weak battery (warning)
 - p. high AC voltage (shutdown)
 - q. low AC voltage (shutdown)

- r. under frequency (shutdown)
 - s. over current (warning)
 - t. over current (shutdown)
 - u. short circuit (shutdown)
 - v. over load (warning)
 - w. emergency stop (shutdown)
 - x. (4) configurable conditions
3. Provisions shall be made for indication of four customer specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

F. Engine Status Monitoring.

1. The following information shall be available from a digital status panel on the generator set control :
 - a. engine oil pressure (psi or kPA)
 - b. engine coolant temperature (degrees F or C)
 - c. engine oil temperature (degrees F or C)
 - d. engine speed (rpm)
 - e. number of hours of operation (hours)
 - f. number of start attempts
 - g. battery voltage (DC volts)
2. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

G. Engine Control Functions.

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of

discriminating between failed sender or wiring components, and an actual failure conditions.

H. Alternator Control Functions:

1. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445. The protection for this function shall be 3rd party certified to verify performance.
3. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445. The protection for this function shall be 3rd party certified to verify performance.
4. Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
5. A line to neutral sensing AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage

shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

6. When required by National Electrical Code or indicated on project drawings, the control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.
7. The generator set control shall include a 120 vac control heater, 200 watts minimum.

I. Control Interfaces for Remote Monitoring:

1. The control system shall provide four programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: (1) generator set operating at rated voltage and frequency (generator running), (2) common warning (common pre-alarm), (3) common shutdown (common alarm), (4) low fuel pressure.

2.6 OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET

- A. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under over current conditions. The supplier shall submit time over current characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.
- B. Outdoor Weather-Protective Enclosure (level 2 sound attenuated):
 1. The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

2. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color using a two step electro coating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
 - a. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.
 - b. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.
 - c. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
 - d. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
 - e. Salt Spray, per ASTM B117-90, 1000+ hours.
 - f. Humidity, per ASTM D2247-92, 1000+ hours.
 - g. Water Soak, per ASTM D2247-92, 1000+ hours.
3. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
4. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
5. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.
6. The enclosure shall include the following maintenance provisions:
 - a. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
 - b. External radiator fill provision.
7. Provide an external emergency stop switch that is protected from accidental actuation.
8. Provide a panelboard mounted within the enclosure. Panelboard shall be rated 240 vac, 1-phase, 3-wire, 100 amp. The feeder to the panelboard will be rated at 240/120 volt, 100 amp. The panelboard shall power all loads within the generator enclosure.
9. Provide fixed louvers. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation.
10. Inlet ducts shall include rain hoods.
11. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in an ambient temperature of up to 100F. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 73 dBA at any location 7 meters from the generator set in a free field environment.
12. The enclosure shall be insulated with non-hydroscopic materials.
13. Engine Generator Mounting:
 - a. Vibration Isolators: Rubber pads.

- b. Vibration Isolation: Provide flexible connections between engine-generator set and fuel lines, exhaust system, electrical conduits, and other externally connected support system.
- c. Anchor Bolts: Type 316 stainless steel.
- d. A template shall be furnished by the manufacturer for setting anchor bolts, pipe sleeves, and nuts for mounting.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests

- 1. Provide results of tests and evaluations previously performed on prototype generator sets representative of the models to be provided, per NFPA 110.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the conditions under which the Work is to be installed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install engine generator systems in accordance with the Drawings, approved Shop Drawings, and manufacturer's recommendations.
- B. Equipment shall be installed by the Contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Contractor shall provide two duplex GFI receptacles: One inside the enclosure, and one a weatherproof-while-in use receptacle on the outside of the enclosure.
- F. Equipment shall be initially started and operated by representatives of the manufacturer.

- G. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.3 FIELD QUALITY CONTROL

- A. Supplier's Services: Provide a qualified, factory trained serviceman to perform the following:
 - 1. Inspect and adjust the equipment after installation and ensure that it operates properly.
 - 2. Instruct Owner's personnel in the operation and maintenance of the equipment.
 - 3. The representative shall make a minimum of 2 visits, with a minimum of 4 hours onsite for each visit. The first visit shall be for checking the completed installation and start-up of the system; the second visit shall be to instruct operations and maintenance personnel.
- B. The engine-generator sets shall be field tested in accordance with NFPA 110. Provide all equipment, including load banks, lubricants and material required for field testing.
- C. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer. The Engineer shall be notified in advance and shall have the option to witness the tests.
- D. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
- E. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.
- F. Training:
 - 1. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.
- G. Adjust equipment as required for proper operation.

3.4 SEQUENCE OF OPERATION

- A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control.
- B. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 - 1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.
 - 2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.
 - 3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- C. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.
- D. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
 - 1. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

+ + END OF SECTION + +

SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install automatic transfer switches.
2. Switches specified under this Section include both open and enclosed types. Open type switches shall be factory tested and shipped to motor control center manufacturer for mounting and connection as specified in Section 26 24 19, Motor Control Centers.

B. Related Sections:

1. Section 26 05 53, Identification for Electrical Systems.
2. Section 26 24 19, Motor Control Centers.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. IEEE 472, Guide for Surge Withstand Capability Tests.
2. IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
3. IEEE C62.41, Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits.
4. NEMA ICS1 109, Tests and Procedures.
5. NEMA ICS10, AC Automatic Transfer Switches.
6. UL 1008, Transfer Switch Equipment.
7. UL 508, Industrial Control Equipment
8. UL 61010B-1 (previously UL 3111-1), Electrical Measuring and Test Equipment; Part 1: General Requirements.
9. ANSI C37.90a, Surge Withstand Capability Test (formerly IEEE Standard 472-1974) – Ring Wave Test.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NEC Article 700, Emergency Systems.
2. NEC Article 701, Legally Required Standby Systems.
3. NEC Article 702, Optional Standby Systems.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of transfer switches to be provided, including ratings and location of each.
 - b. Equipment dimensions, and construction details of enclosures with conduit entry locations.
 - 2. Product Data:
 - a. Manufacturer's technical information for products proposed, including catalog cut sheets.
 - 3. Test Procedures:
 - a. At least thirty days prior to actual factory and field testing, submit proposed testing procedures, methods and apparatus.
- B. Informational Submittals:
 - 1. Source Quality Control Submittals:
 - a. Submit reports of completed factory tests, including test results and procedures used for testing.
 - 2. Field Quality Control Submittals:
 - a. Submit reports of completed field tests, including test results and procedures used for testing.
 - 3. Supplier Instructions:
 - a. Manufacturer's written instructions for transporting, handling, storing, and installing the products.
 - 4. Supplier Reports:
 - a. Written report of each visit to Site by supplier's service representative.
- C. Closeout Submittals
 - 1. Operation and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
 - c. Furnish operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts and Extra Stock Materials: Provide as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices to be embedded in cast-in-place concrete in time to prevent delay of the Work.

- B. Shipping sections shall be designed to be shipped by truck, rail, and ship. Indoor sections shall be bolted to skids.
- C. Equipment shall be equipped to be handled by crane. Where cranes are not available equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the sections.
- D. Comply with Section 01 65 00, Product Delivery Requirements, and Section 01 66 00, Product Storage and Handling Requirements.

1.6 MAINTENANCE

- A. Spare Parts and Extra Stock Materials:
 - 1. Furnish, tag, and box for shipment and long term storage the following spare parts for each switch:

Item	Quantity per Switch
a. Control relay	Two of each type used
b. Pilot light	Two per ten of each type used
c. Fuses	Two set of each type and size used

- 2. Furnish a list of additional recommended spare parts for an operating period of one year. Describe each part, quantity recommended, and current unit price of each.
- 3. Package spare parts in suitable containers bearing labels clearly indicating contents and equipment with which they are to be used. Deliver spare parts at same time as switchgear.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Provide automatic transfer switches as specified for transferring loads from one power source to another.

2.2 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. Russelectric, Inc.
 - 2. ASCO Power Technologies.
 - 3. Or equal.

2.3 SWITCH

A. Ratings:

1. Switches shall be capable of switching all classes of loads and rated for continuous duty when installed in a non-ventilated enclosure.
2. Switches shall be rated with continuous ampere rating, number of poles and voltage as shown on Drawings.
3. Switches shall be rated to withstand the magnitude of fault current available without welding of contacts in compliance with ANSI C37.90a and IEEE C62.41.

B. Standards and Performance:

1. Switches shall comply with UL Standard 1008, NEMA Standard ICS10, and applicable requirements of NEC Article 700, IEEE 446, IEEE C62.41, UL 508, and UL 61010B-1. Switches shall be UL labeled with performance meeting or exceed the following:
 - a. Temperature Rise: Measurements shall be made after overload and endurance tests.
 - b. Withstand: UL listed to withstand magnitude of fault current available at switch terminals when coordinated with respective protective devices shown on Drawings at an X/R ratio of 6.6 or less. Main contacts shall not trip open or weld when subjected to fault currents.
 - 1) As a condition for approval, manufacturer of automatic transfer switches shall verify that switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with three-cycle short circuit closing and withstand as follows:

RMS Symmetrical Amperes at 480 VAC	
Amperes	3 Cycle Closing & Withstand
100 to 400	42,000
600 to 800	65,000
1000 to 1200	85,000
1600 to 4000	100,000

- 2) During three-cycle closing and withstand tests, there shall be no contact welding or damage. Three-cycle tests shall be performed without using current limiting fuses, and oscillograph traces across main contacts shall be furnished to verify that contact separation has not occurred, and there is contact continuity across all phases after completion of testing. Test procedures shall be in accordance with UL-1008, and testing shall be certified by UL.
- 3) When conducting temperature rise tests to UL-1008, Supplier shall include post-endurance temperature rise tests to verify ability of transfer switch to carry full rated current after completing overload and endurance tests.

- c. Dielectric: Measurements shall be made at 1960 VAC RMS minimum following the withstand current rating test.
- d. Transient Withstand: Control panel shall pass the voltage surge withstand test per IEEE Standard 472 and voltage impulse withstand test per NEMA ICS1 109.

C. Construction:

- 1. Switch shall be double throw actuated by non-fused, momentarily energized operating mechanism(s).
- 2. Accomplish mechanical locking of main contacts in each direction without aid of latching solenoids, toggle mechanisms, or gear arrangements.
- 3. An overload or short-circuit shall not cause switch to go to a neutral position.
- 4. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- 5. Switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- 6. Main contacts shall be silver-tungsten composition. Switches shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- 7. Inspection of contacts shall be possible from front of switch without disassembly of operating linkages and without disconnecting power conductors. Switches rated 600 amps and higher shall have front-removable and -replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors or bus bars.
- 8. Transfer switch shall be equipped with a safe manual operator designed to prevent injury to operating personnel. Manual operator shall provide same contact-to-contact transfer speed as electrical operator to prevent a flash-over from switching main contacts slowly. Manual operation shall be safe even if electrical operator becomes energized and shall not require prior disconnection of operators or control wiring. Safe manual transfer shall be possible under all load conditions, energized or non-energized. Manual operator shall be an external type, operable through door of transfer switch enclosure. Operating personnel shall not be required to open transfer switch door to facilitate manual transfer. Manual operator shall be functional at all times, regardless of switch position or status. Manually initiated electrical operation does not meet intent of this requirement. Manual operator is not required on closed transition type switches.

D. Enclosure: Enclosed switches shall be NEMA 3R at minimum.

- 1. Standard and optional door-mounted switches and pilot lights shall be 30.5-mm industrial grade type or equivalent.
- 2. Provide door controls on a separate, removable plate that can be supplied loose for open type units.

- E. Identification: Identify switches per Section 26 05 53, Identification for Electrical Systems.

2.4 TRANSFER SWITCHING FEATURES

- A. Delay Transition (Open): Provide automatic delayed open transition transfer for each switch. Switch shall transfer load in delayed transition (break-before-make) mode. Transfer shall be accomplished with a user-defined interruption period in both directions adjustable from one second to five minutes in at least 15 increments.

2.5 SEQUENCE OF OPERATION

- A. When voltage on any phase of normal source is outside of specified parameters and after a programmable time delay period to allow for momentary dips, engine starting contacts shall close to start generating supply.
- B. Transfer switch shall transfer to emergency source when generating supply has reached specified voltage and frequency on all phases.
- C. After restoration of normal supply on all phases to within specified parameters, an adjustable time delay shall delay retransfer to normal to assure stabilization of normal supply. After expiration of the time delay period, transfer switch shall retransfer to normal. Should emergency supply source fail during the time delay period, switch shall bypass time delay and automatically return to normal source. Provide an adjustable time delay between opening of closed contacts and closing of open contacts during transfers to allow loads to be demagnetized.
- D. After retransfer to normal, engine generator shall be allowed to operate at no load for a programmable period to cool down.
- E. Should transfer to emergency source be initiated by test switch rather than an actual source failure, transfer from normal to emergency shall be as described above.

2.6 MICROPROCESSOR CONTROLLER

- A. Each switch shall include a microprocessor controller for operation of the switch. Equip controller with the following:
 - 1. Provide controller's sensing and logic by a built-in microprocessor with ability to communicate serially through an optional serial communication module.
 - 2. Controller shall provide a minimum of five selectable nominal voltages. Voltage sensing shall be true RMS type and be accurate to plus/minus one percent of nominal voltage. Frequency sensing shall be accurate to plus/minus 0.2 percent. Controller shall be capable of operating over a

temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

3. Connect controller to transfer switch by an interconnecting wiring harness that shall include a keyed disconnect plug to enable controller to be disconnected from transfer switch for routine maintenance. Interfacing relays shall be industrial grade plug-in type with dust covers. Enclose controller with a protective cover. Mount controller internally but separately from transfer switch.
4. Customer connections shall be wired to a common terminal block.

B. Controller Display and Keypad:

1. Display and keypad shall be an integral part of controller for viewing available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through serial communications input port. The following parameters shall be adjustable:
 - a. Nominal line voltage and frequency
 - b. Single- or three-phase sensing
 - c. Operating parameter protection
 - d. Transfer operating mode configuration: Open transition, closed transition or delayed transition
2. Instructions and controller settings shall be easily accessible, readable, and accomplished without using codes, calculations, or instruction manuals.

C. Controller Voltage, Frequency and Phase Rotation Sensing:

1. Voltage and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities values shown as a percent nominal unless otherwise specified:

Parameter	Sources	Dropout/Trip	Pickup/Reset
Under-voltage	Normal and Emergency, three-phase	70 to 98%	85 to 100%
Over-voltage	Normal and Emergency, three-phase	102 to 115%	2% below trip
Under-frequency	Normal and Emergency	85 to 98%	90 to 100%
Over-frequency	Normal and Emergency	102 to 110%	2% below trip
Voltage Unbalance	Normal and Emergency	5 to 20%	1% below dropout

2. Repetitive accuracy of all settings shall be within plus/minus 0.5 percent over an operating temperature range of -20 degrees C to +60 degrees C.
3. Voltage and frequency settings shall be field adjustable in one percent increments, either locally with the display and keypad or remotely via serial communications port access.
4. When activated by keypad or through serial port, controller shall be capable of sensing phase rotation of both normal and emergency sources. Source will be unacceptable if phase rotation is not preferred rotation selected (ABC or CBA).

5. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all three phases, frequency, and phase rotation.
- D. Controller Time Delays:
1. Provide controller with time delays below. Time delay settings shall be adjustable over a range of zero to 9999 seconds (factory set at three seconds) unless specified otherwise.
 - a. Normal source failure, for engine starting.
 - b. Transfer to emergency on availability of emergency source.
 - c. Emergency source failure, retransfer on availability of normal source.
 - d. Engine cool down following retransfer to normal.
 - e. Time delay to control contact transition time during open transition transfer to either source.
 - f. All timers can be bypassed via operation on processor's keypad.
 2. Provide adjustable time-delay on retransfer to normal. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.
 3. Provide a time delay activated output signal to drive external relays for selective load disconnect control. Controller shall have the ability to activate an adjustable zero to five-minute time delay for one of the following modes:
 - a. Prior to transfer only.
 - b. Prior to and after transfer.
 4. Time delay and sensing functions shall be field adjustable and operate with drift that does not exceed plus/minus one percent of set frequency, plus/minus two percent of set voltage, and plus/minus ten percent of set time delay, over the temperature range of -20 degrees C to +70 degrees C.
 5. Time delays shall be adjustable in one-second increments, except extended parallel time, that shall be adjustable in 0.01-second increments.
 6. Time delays shall be adjustable by using display and keypad or with a remote device connected to serial communications port. Time delay value displayed shall be time remaining until next event occurs.
 7. For (open) delay transition transfer switches controller shall include the following built-in time delays for delayed transition operation:
 - a. Zero to five-minute time delay for load disconnect position for delayed transition operation.

2.7 ACCESSORY FEATURES:

- A. Provide each switch with the following:
1. A two-position maintained-type test switch for test/automatic/ modes. Test position shall simulate a normal source failure.
 2. A SPDT silver-tungsten contact, rated five amps at 30 VDC, for a low-voltage engine start signal. Start signal shall prevent dry cranking of engine by requiring generator set to reach proper output and run for duration of

cool down setting regardless of whether normal source restores before load is transferred.

3. Auxiliary contacts, rated ten amps at 250 VAC, consisting of one contact, closed when switch is connected to normal source and one contact closed when switch is connected to emergency source.
4. LED indicating lights (30.5 mm, industrial heavy duty, oil-tight, NEMA rated to match automatic transfer switch enclosure). One shall indicate when switch is connected to normal source (green) and one to indicate when the switch is connected to emergency source (red).
5. LED indicating lights (30.5 mm, industrial heavy duty, oil-tight, NEMA rated to match automatic transfer switch enclosure), energized by controller outputs. Lights shall provide true source availability of normal and emergency sources as determined by voltage sensing trip and reset settings for each source.
6. Provide the following built-in to controller, capable of being activated through keypad programming or serial port only when required by user:
 - a. Provide ability to select “commit/no commit to transfer” to determine whether load should be transferred to standby generator if normal source restores before generator is ready to accept load.
 - b. Provide terminals for a remote contact that opens to signal switch to transfer to emergency, and for remote contacts that open to inhibit transfer to emergency or retransfer to normal. Provide ability to activate both inhibit signals through keypad or serial port.
 - c. Controller shall be capable of accepting a normally open contact that will allow transfer switch to function in a non-automatic mode using an external control device.
 - d. Engine Exerciser: Controller shall provide an internal engine exerciser that allows user to program up to seven different exercise routines. For each routine, user shall be able to:
 - 1) Enable or disable routine.
 - 2) Enable or disable transfer of load during routine.
 - 3) Set start time.
 - 4) Time of day
 - 5) Day of week
 - 6) Week of month (first, second, third, fourth, last, alternate, and every)
 - 7) Set duration of run.
 - 8) At end of specified duration, switch shall transfer load back to normal and run generator for specified cool down period. A ten-year life battery that supplies power to real time clock in event of a power loss shall maintain time and date information.
7. System Status: Controller display shall include a “System Status” screen that shall be readily accessible from all points in the menu by a maximum of two key strokes. System status screen shall display a clear description of active operating sequence and switch position.

8. Self-Diagnostics: Controller shall contain a diagnostic screen for detecting system errors. Screen shall provide information on status input signals to controller that may be preventing completion of load transfer commands.
9. Communications Interface: Controller shall be capable of interfacing, through an optional full-duplex RS 485 serial communication module, with a network of transfer switches, within 4,000 feet (locally) and remotely through modem serial communications. Standard software specific for transfer switch applications shall be available from transfer switch manufacturer. Software shall include monitoring, control, and setup of parameters.
10. Data Logging: Controller shall have ability to log data and to maintain last 99 events, even during total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
 - a. Event Logging
 - 1) Date and time and reason for transfer normal to emergency.
 - 2) Date and time and reason for transfer emergency to normal.
 - 3) Date and time emergency source available.
 - b. Statistical Data
 - 1) Total number of transfers.
 - 2) Last ten numbers of transfers due to source failure.
 - 3) Total number of hours both normal and emergency sources are available.
11. Terminate control wires with crimp lugs and identify with sleeve type markers. Provide suitable copper connector lugs for each service and load connections.

2.8 BYPASS-ISOLATION SWITCH

- A. Provide separate bypass and isolation handles. Handles shall be permanently affixed and operable without opening enclosure door. Designs requiring insertion of loose operating handles or opening of enclosure door to operate are unacceptable.
- B. Bypass handle shall have three operating modes: "Bypass to Normal", "Automatic", and "Bypass to Emergency". Operating speed of bypass contacts shall be the same as associated transfer switch and be independent of speed at which manual handle is operated. In "Automatic" mode bypass contacts shall be out of power circuit so that they will not be subjected to fault currents to which system may be subject.
- C. Isolation handle shall provide three operating modes: "Closed", "Test", and "Open". "Test" mode shall allow testing of entire emergency power system, including automatic transfer switches with no interruption of power to load. "Open" mode shall completely isolate automatic transfer switch from source and load power conductors. In "Open" mode, it shall be possible to completely withdraw automatic transfer switch for inspection or maintenance to conform to

code requirements without removing power conductors and without requiring tools.

- D. When isolation switch is in “Test” or “Open” modes, bypass switch shall function as a manual transfer switch.
- E. Break-before-make Design Bypass Isolation Switch:
 - 1. Break-before-make bypassing shall be by means of a single, externally operated handle. Handle shall allow direct, one step bypass to either normal source or to emergency source, regardless of position or condition of transfer switch. Designs requiring multiple steps, bypassing to other than desired source, or that are dependent on electrical operation of transfer switch are not acceptable. Bypass operation shall not be dependent upon electrical device or interlocks for safety purposes or for proper sequencing.
 - 2. Isolating shall be by a second externally operated handle. For safety purposes, operation of isolating handle shall disconnect all electrical power to transfer switch.
 - 3. Necessary controls shall be provided to assure that “engine run” circuit shall remain closed if bypass switch is in bypass to emergency position, regardless of status of transfer switch signals.
 - 4. Indicating lights shall be provided to show the following:
 - a. Amber LED to indicate normal power available.
 - b. Amber LED to indicate emergency power available.
 - c. Green LED:
 - 1) Constant: Indicates load bypassed to normal source, isolating contacts closed, transfer switch energized.
 - 2) Flashing: Indicates load bypassed to normal source, isolating contacts open, transfer switch bypassed and isolated
 - d. Red LED:
 - 1) Constant: Indicates load bypassed to emergency source, isolating contacts closed, transfer switch energized.
 - 2) Flashing: Indicates load bypassed to emergency source, isolating contacts open, transfer switch bypassed and isolated.
 - 5. The automatic transfer switch and the bypass isolation switch shall be mounted in a common enclosure, and be separated by barrier from each other. Provide separate hinged doors with individual lockable handles for transfer switch section and bypass switch section.
 - 6. Transfer switch shall be of draw-out design. Draw-out shall be via draw-out carriage that disconnects all power and control connections from transfer switch so that switch is completely isolated and electrically de-energized.
 - 7. Interconnections between transfer switch and bypass isolation switch shall be made by manufacturer so that installer shall be required only to make external power and control connections to lugs or terminal strips at bypass/isolation switch to complete installation. Power interconnections shall be silver-plated copper bus bar.

8. Automatic transfer switch and bypass isolation switch shall be mounted in a common enclosure, and be separated by barrier from each other. Provide separate hinged doors with individual lockable handles for transfer switch section and bypass switch section.
9. To facilitate safe and easy removal of transfer switch for maintenance and repair, transfer switch shall be of draw-out design. Draw-out shall be via draw-out carriage that disconnects all power and control connections from transfer switch so that switch is completely isolated and electrically de-energized.
10. Interconnections between transfer switch and bypass isolation switch shall be made by manufacturer so that installer shall be required only to make external power and control connections to lugs or terminal strips at bypass/isolation switch to complete installation. Power interconnections shall be silver-plated copper bus bar.

2.9 DATA MONITOR

- A. Provide a data monitor for each switch to monitor all functions specified. Flush-mount monitor on switch enclosure and equip monitor with continuous duty, long-life, lit display.
- B. Data monitors shall be rated for an operating temperature range of -20 degrees C to +60 degrees C.
- C. Data monitor shall be accurate to one percent measured, two percent computed values and display resolution to 0.1 percent. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).
- D. Data monitor shall be capable of operating without modification at nominal frequencies of 45 to 66 Hertz and over a control power input range of 20 to 32 VDC.
- E. Data monitor shall accept inputs from industry standard instrument transformers, including five-amp secondary current transformers. Direct-phase voltage connections, 600 VAC and under, shall be possible without using potential transformers.
- F. Data monitor shall be applied in single, three-phase, or three- and four-wire circuits.
- G. Setup parameters required by data monitors shall be stored in non-volatile memory and retained during control power interruption.

- H. Metered readings listed below shall be available from display and transmitted remotely by serial communications module. Transmit data in format compatible with plant monitoring and control system.
 - 1. Current, per phase RMS.
 - 2. Current unbalance percentage
 - 3. Voltage, phase-to-phase, and phase-to-neutral
 - 4. Voltage unbalance percentage
 - 5. Real power (KW), per phase and three-phase total
 - 6. Apparent power (KVA), per phase and three-phase total
 - 7. Reactive power (KVAR), per phase and three-phase total
 - 8. Power factor, three-phase total and per phase
 - 9. Frequency.
 - 10. Accumulated energy, (MWH, MVAH, and MVARH)
- I. The following energy readings shall be communicated by data monitor:
 - 1. Accumulated real energy (KWH)
 - 2. Accumulated reactive energy (KVAH)
 - 3. Accumulated apparent energy (KVARH)
 - 4. Real and reactive energy reported values for the load circuit.
- J. Data Monitor Input/Output Options.
 - 1. Provide data monitors with the following inputs and outputs:
 - a. Eight solid state status inputs.
 - b. Four relay output contacts
- K. Provide menu scroll buttons to display data monitor quantities.
- L. Display shall remain continuously on, without detrimental effect on life of data monitor.
- M. Setup for system requirements shall be via the front of data monitor. Setup provisions shall include:
 - 1. CT Rating: Five ampere secondary and primary rating equal to automatic transfer switch rating.
 - 2. System Type: Single, three-phase; three- and four-wire.
 - 3. Communication parameters
- N. Provide capability to reset the following electrical parameters front of data monitor:
 - 1. Real energy (MWH), apparent energy (MVAH), and reactive energy (MVARH).
 - 2. All reset and setup functions shall have a means for protection against unauthorized and accidental changes.

2.10 SOURCE QUALITY CONTROL

- A. Perform manufacturer's standard factory tests that shall include:
 - 1. Physical inspection and checking of components.
 - 2. Mechanical operation and device functional tests.
 - 3. Control operation and functionality tests.
 - 4. Primary, control, and secondary wiring hi-pot tests.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Install equipment in accordance with Contract Documents and manufacturer recommendations.
- C. Securely fasten equipment to floors, walls, or other surfaces on which equipment will be mounted. Install freestanding switches on raised concrete pad at locations shown on Drawings. Install in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

- A. Perform field testing and inspection of each automatic transfer switch. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative, who shall inform OWNER and ENGINEER when equipment has been correctly installed. Do not energize equipment without permission of OWNER.

3.4 MANUFACTURER SERVICES

- A. Manufacturer Services:
 - 1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of equipment and installation at equipment's final location. In advance of installation, representative shall train installing personnel in proper handling and rigging of equipment, for at least one eight-hour days at the Site.

2. Manufacturer's factory-trained representative shall test the system as specified in Article 3.3 of this Section. Representative shall operate and test system in the presence of ENGINEER and verify that equipment conforms to requirements. These services shall be at least one eight-hour days at the Site.
 3. Manufacturer's factory-trained representative shall adjust the system to initial settings specified in Article 2.6 of this Section.
 4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
 5. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the Correction Period specified in the General Conditions as amended by the Supplementary Conditions.
 6. Replacement parts or equipment installed during the Correction Period shall be equal to or better than the original.
- B. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of the products. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 26 43 00

SURGE PROTECTIVE DEVICES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).
2. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

B. Related Sections:

1. Section 26 05 05, General Provisions for Electrical Systems.
2. Section 26 24 19, Motor Control Centers.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/UL 1449, Surge Protective Devices.
2. IEEE C62.11, Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)
3. IEEE C62.41, Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits.
4. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
5. UL 1283, Electromagnetic Interference Filters.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have at least five years experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.
2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

- C. Regulatory Requirements: Comply with the following:
 - 1. NEC 110.9, Requirements for Electrical Installations, Interrupting Rating.
 - 2. NEC 240.21, Overcurrent Protection, Location in Circuit.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.
 - b. Components list and nameplate schedule.
 - c. Summary sheets with schedules of equipment.
 - 2. Product Data:
 - a. Manufacturer's technical information, including catalog information.
 - b. Manufacturer's technical specifications with assembly and component ratings.
- B. Informational Submittals: Submit the following:
 - 1. Certifications:
 - a. Certification that SPD devices comply with standards referenced in this Section.
 - 2. Source Quality Control Submittals:
 - a. Report of results of testing and inspections performed at manufacturer's shop.
 - 3. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 - 4. Qualifications Statements:
 - a. Manufacture, when requested by ENGINEER.
- C. Closeout Submittals: Submit the Following
 - 1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 01 78 23, Operations and Maintenance Data.
 - b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
 - 2. Warranty Documentation: Submit example warranty at time of shipment of the equipment. Include final warranty accepted by ENGINEER in the operations and maintenance manual for the equipment.

1.5 DELIVERY, STORAGE, AND HANDLING.

- A. Delivery:
 - 1. Upon delivery, check for evidence of water that may have entered equipment during transit.
- B. Storage:
 - 1. Store SPD equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
 - 2. Protect equipment from corrosion and deterioration.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty on Materials and Equipment:
 - 1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials or equipment specified in this Section found to be defective during a period of five years after the date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide equipment of one of the following:
 - 1. General Electric.
 - 2. Schneider Electric/Square-D Company.
 - 3. Eaton/Cutler-Hammer.
 - 4. Or equal.

2.2 EQUIPMENT

- A. General:
 - 1. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.
 - 2. SPD shall comply with requirements of the following:
 - a. ANSI/UL 1449.
 - b. UL 1283.

- c. IEEE C62.11, IEEE C62.41 and IEEE C62.45.
 3. SPD shall be suitable for operation under the following environmental conditions:
 - a. Relative Humidity: Zero to 95 percent, non-condensing.
 - b. Frequency: 47 to 63 Hertz.
 - c. Temperature: Zero to 149 degrees F.
 4. SPD operating voltage and IEEE C62.41 and IEEE C62.45 Category A, B, and C application environments shall be suitable for the associated SPD location(s) shown or indicated on the Drawings.
 5. SPD shall be suitable for internal and external mounting. Where shown on the Drawings, SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:
 - a. Section 26 24 19, Motor Control Centers.
- B. SPD shall include a surge suppression path for each mode as required for the system configuration shown on the Drawings. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:
1. Line-to-line.
 2. Line-to-neutral.
 3. Line-to-ground.
 4. Neutral-to-ground.
- C. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.
- D. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115 percent of nominal system operating voltage.
- E. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	208Y/120	480Y/277
L-N,L-G, N-G	800	1200
L-L	1200	2000

- F. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	Application	Per Phase	Per Mode
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

2.3 ACCESSORIES

- A. Provide SPD equipped with the following accessories:
 - 1. Surge counter with display for indicating the number of surges detected.
 - 2. LED indicators for monitoring device status.
 - 3. Audible alarm and silence switch for indicating an inoperative condition.
 - 4. Dry contacts, "Form C", for remote annunciation of unit status.
 - 5. Indicators, counter, alarm, and silence switch shall be visible and accessible from front of the SPD. When SPD is integral to switchgear, motor control center, panelboard, or other equipment, indicators, counter, alarm, and silence switch shall be visible and accessible from front of the equipment in which the SPD is installed.

2.4 SOURCE QUALITY CONTROL

- A. Perform manufacturer's standard factory tests on equipment. Tests shall be in accordance with IEEE C62.45 and ANSI/UL 1449.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install SPD at locations shown on the Drawings in accordance with equipment manufacturer's recommendations, Laws, and Regulations, and the Contract Documents.
- B. Conductor length between suppressor and connection point shall be as short and as straight as possible.

+ + END OF SECTION + +

+ +NO TEXT ON THIS PAGE+ +

SECTION 26 50 00

LIGHTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install lighting fixtures and associated controls.

B. Coordination:

1. Coordinate location of fixtures with piping, ductwork, openings, and other systems and equipment and locate clear of interferences.
2. Coordinate fixtures to be mounted in hung ceilings with the ceiling suspension system proposed.

C. Related Sections:

1. Section 26 05 05, General Provisions for Electrical Systems.
2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. UL 844, Luminaires for Use in Hazardous (Classified) Locations.
2. UL 935, Safety of Fluorescent Lamp Ballasts.
3. UL 1029, Safety of High-Intensity- Discharge Lamp Ballasts.
4. UL 1598, Safety of Luminaires.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 410, Luminaires, Lampholders, and Lamps.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Schedule of light fixtures to be furnished, indicating fixture type and location for each.
 - b. Customized wiring diagrams.
2. Product Data:
 - a. Manufacturer's technical information, specifications, standard wiring diagrams, and catalog cuts for lighting fixtures proposed.

- b. Fixture construction details.
 - c. ETL photometric and isocandle curves for each fixture proposed.
 - d. Verification that recessed fixtures to be mounted in hung ceilings are compatible with ceiling suspension system proposed.
- B. Informational Submittals: Submit the following:
 - 1. Manufacturer's Instructions:
 - a. Instructions and recommendations for handling, storing, and protecting the equipment.
 - b. Installation instructions for the equipment, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
- C. Maintenance Material Submittals: Submit the following:
 - 1. Spare Parts and Extra Stock Materials: Furnish spare parts for each type of unit required as indicated in Part 2 of this Section.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 - 1. Upon delivery, inspect equipment for evidence of water that may have entered equipment during transit.
- B. Storage:
 - 1. Store lighting fixtures, controls, related materials and equipment in clean, dry location with controls for uniform temperature and humidity. Protect materials and equipment with coverings and maintain environmental controls.
 - 2. Store materials and equipment for easy access for inspection and identification. Keep materials and equipment off ground, using pallets, platforms, or other supports. Protect materials and equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Type: Lighting fixtures required shall be in accordance with the Lighting Fixture Schedule Drawings. Fixtures shall be complete with supports, ballasts, lamps, and incidentals, as required.
- B. Fixtures in hazardous locations shall be listed in accordance with UL 1598 and UL 844.
- C. Lamps:
 - 1. Fluorescent: Fluorescent lamps shall be toxic characteristic leaching procedure (TCLP) compliant for low mercury content. Linear fluorescent lamps shall be T5, energy-efficient, extended life type. Compact fluorescent lamps shall be long-life, energy-efficient type.

2. Light emitting diode (LED): Characteristics as shown on the fixture schedule
 3. Spare Parts and Extra Stock Materials: Ten percent spare lamps of each type and wattage.
- D. Ballasts:
1. Fluorescent: UL 935 listed, high power factor, energy-efficient type, equipped with thermal protectors (Type “P” ballast), compatible with lamps installed. Indoor two-lamp fluorescent ballasts shall be electronic type with total harmonic distortion of less than 20 percent. Ballast factor shall be 0.85 minimum with total of less than 61 watts input. Provide cold weather type ballast where indicated in the Lighting Fixture Schedule.
 2. High Intensity Discharge: UL 1029 listed, high power factor, constant wattage, stabilized autotransformer with line starting current the same or less than operating current.
 3. Ballasts sound level shall be 30 decibels or less, sound rating “A”.
 4. Ballasts shall be Edison Testing Laboratories (ETL) listed and Certified Ballast Manufacturer Association, CMB-certified.
 5. For fixtures utilizing double-ended lamps, provide fixture disconnecting means within the fixture.
 6. Spare Parts and Extra Stock Materials: Ten percent spare ballasts of each type and quantity, but not less than one.
- E. Fixtures located in area identified as hazardous in Section 26 05 05, General Provisions for Electrical Systems, shall each be approved as a complete assembly, shall be clearly marked to indicate maximum wattage of lamps for which they are approved, and be protected against physical damage by suitable guards.
- F. Hardware: Provide necessary hangers, supports, conduit adaptors, reducers, hooks, brackets, and other hardware required for safe fixture mounting. Hardware shall have protective, non-corrosive finish.
- G. Outdoor Fixtures: Provide each fixture to be installed outdoors with cut-off lens to reduce the fixture’s light pollution emissions.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:

1. Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to clear conflicts and obstructions.
 2. Mounting Heights: Mounting heights or elevations are to bottom of fixture or to centerline of device.
 3. Install fixtures in accordance with Laws and Regulations, the Contract Documents, and manufacturer instructions and recommendations.
 4. Mount fixtures so that sufficient access is available for ready and safe maintenance.
 5. Securely fasten equipment to walls or other surfaces on which equipment is mounted.
- B. Suspended Fixtures:
1. Pendant-mount using 1/2-inch diameter conduit stems.
 2. Ground to outlet box.
 3. Attach mounting to building structure with expansion anchors.
 4. Fixtures shall not be dependent on the outlet box cover screws for support.
- C. Surface Mounted Fixtures:
1. Attach to appropriate outlet box.
 2. Attach to surface using fasteners and sealing washers when mounting fixture in damp or wet locations.
- D. Boxes and Fixtures:
1. For units mounted against masonry or concrete walls, provide suitable 1/4-inch spacers to prevent mounting back of box directly against wall.
 2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers, or Unistrut.
 3. Do not install boxes with open conduit holes.
 4. Cable each circuit and identify with tag.
- E. Re-lamp all fluorescent fixtures provided under this Contract with new lamps following Substantial Completion.
- F. Mount photocells as shown and adjust foot-candle setting for proper dusk and dawn photo-control. Provide wiring in conduit from photocell to controls.

+ + END OF SECTION + +

SECTION 31 10 00

SITE CLEARING

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Protecting existing trees, shrubs and grass to remain.
 - 2. Removing existing trees, shrubs, groundcovers, plants and grass.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above- and below-grade site improvements.
 - 6. Disconnecting and capping or sealing site utilities.
 - 7. Temporary erosion and sedimentation control measures.

1.2 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.

1.3 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. Salvable Improvements: 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

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 20 00 "Earth Moving."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 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.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.

3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.

- B. 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 Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.

3.5 CLEARING AND GRUBBING

- A. 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.

3.6 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.
- 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.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.8 DISPOSAL

- A. Disposal: 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.
 - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all materials, labor, equipment, and services necessary to perform the work of this section as shown on the Drawings, as specified, and as required by job conditions, including, but not limited to, the following:
 - 1. General excavation for structures and other site improvements.
 - 2. Preparation of subgrade for slabs on grade, footings, etc., including control of excess moisture.
 - 3. Providing a vapor retarder where indicated.
 - 4. General excavation and backfill for structures and other site improvements.
 - 5. Trench excavation and fill for underground mechanical, plumbing, fire protection and electrical utilities and appurtenances.
 - 6. Rock / obstruction excavation.
 - 7. Protection of adjacent structures.
 - 8. Soil reuse, including blending, if required.
 - 9. Soil compaction control.
 - 10. Import of fill from off-site sources, if required.
 - 11. Removal of excess materials to off-site, if required.
 - 12. Disposal of unsuitable materials off-site, if required.
 - 13. Management of exposed existing, imported, and excess soil materials.
- B. Identify and establish in the field the correct elevations of and then excavate as required for the following:
 - 1. New concrete foundations, footings, piers, and slabs.
 - 2. New utility lines, utility structures, utility conduits, and for relocation of existing utility lines and utility structures.
 - 3. Existing underground items designated on the Drawings to be removed.
 - 4. New pavement subgrades.
 - 5. New landscaping area subgrades.
 - 6. Non-specified items for which excavation is required.
- C. Coordinate all work with the Owner and that of other trades.

1.2 RELATED WORK

- A. Payment: Division 01.
- B. Site Clearing: Section 31 10 00.
- C. Demolition: Section 02 41 00.
- D. Rock and Boulder Excavation: Section 31 21 00.
- E. Excavation Support and Protection: Section 31 50 00.

- F. Turf and Grasses: Section 32 92 00.
- G. Concrete Work: Division 03.
- H. Exterior Improvements: Division 32.
- I. Utilities: Division 33.

1.3 REFERENCES

- A. State of Connecticut Department of Transportation, Standard Specifications for Roads, Bridges and Incidental Construction, Form 816, latest edition.
- B. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
- C. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
- D. ASTM D2487 - Standard Test Method for Classification of Soils for Engineering Purposes.
- E. ASTM D1556 - 07 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
- F. ASTM D6938 - 10 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods.

1.4 DEFINITIONS

- A. Excavation: Removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed. See EXECUTION section for directions for treatment of excavations in rock.
- B. Unauthorized Excavation: Removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense. See EXECUTION section for instructions for treatment of unauthorized excavation.
- C. Additional Excavation: Excavation required beyond anticipated subgrade elevation. See EXECUTION section for procedures.
- D. Natural Subgrade: The undisturbed, inorganic native soil exposed below site fill and disturbed native soils at footing and/or structural fill bearing elevations; or Rock at least 12" below the footing bearing elevation, slabs on grade, or utilities.

- E. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.
- F. Structural Fill: Imported or approved on site aggregate or select soil meeting the physical properties described in Section 2.1 MATERIALS, and compacted in place to form a supportive bearing surface.
- G. Unsuitable material: On-site materials which are of improper gradation to allow adequate compaction, and/or defined as organically contaminated (including roots), uncontrolled fill material, disturbed native material, or otherwise identified as improper for the intended use by the Engineer.
- H. Rock: All materials which, in the opinion of the Engineer, require blasting or special impact tools such as jack hammers, sledges, chisels or devices similar in purpose which are designed for use in cutting or breaking materials that have compressive strengths in excess of 300 pounds per square inch in their natural states. Boulders larger than 1 cubic yard in volume are classified as Rock.
- I. Common Fill: See MATERIALS section.
- J. Structural Fill: See MATERIALS section.
- K. Crushed Stone Fill: See MATERIALS section.
- L. Processed Aggregate Fill: See MATERIALS section.
- M. Pipe Bedding and Trenching Fill: See MATERIALS section.

1.5 SUBMITTALS

- A. Refer to Section 01 33 00, Submittals.
- B. Test reports: submit the following reports directly to Engineer from the testing services, with copy to Owner:
 - 1. Provide at least one gradation test report for each 500 cubic yards of any fill material used on the project.
 - 2. The Contractor shall submit samples of all soil materials from off-site and on-site sources to the testing laboratory at least ten (10) calendar days prior to use in the work. The Contractor shall not deliver or use any soil materials from off-site or on-site sources until written approval is received from the Engineer based upon test results showing compliance with these specifications.
 - 3. At least one optimum moisture-maximum density curve shall be provided for each type of fill compacted. Additional optimum moisture-maximum density curve testing shall be performed at no cost to the Owner if requested by the Engineer due to variability in fill properties and/or field compaction results.

4. Field reports: in-place density test results shall be provided to the Owner's Representative verbally in the field as they are performed and the associated written results shall be provided to the Engineer not more than 48 hours later.
- C. Submit representative samples of approved equivalent materials, such as filter fabric, for approval prior to delivery to the site.

1.6 QUALITY ASSURANCE

- A. Laboratory Testing: The Owner will retain and pay costs of soil testing and inspections services for quality control testing during earthwork operations.
 1. The Contractor shall schedule and coordinate earthwork operations such that testing and inspection services may occur at intervals as appropriate for progress of the work.
 2. The Contractor shall perform and control its excavation and soil placement activities in a manner designed to achieve required quality results.
- B. Use adequate numbers of workmen who are trained and experienced in the activities to be performed and who are completely familiar with the specified requirements and methods required for proper performance of the work in this Section.
- C. Use equipment of adequate size, capacity, and quantity to accomplish the work of this Section in a safe and timely manner.
- D. Place materials to preserve their quality and the quality of underlying and adjacent materials.
- E. Place and manage materials in a manner that minimizes adverse impacts to stormwater and landscaped areas to remain undisturbed.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving 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 Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 1. Do not proceed with work on adjoining property until directed by Engineer.
- C. Utility Locator Service: Notify "Call Before You Dig (CBYD)" for area where Project is located before beginning earth moving operations.

- D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Section 311000 "Site Clearing", are in place.

1.8 BENCH MARKS, LINES, AND GRADES

- A. Employ a competent Civil Engineer or Land Surveyor, registered in Connecticut, who shall perform the following work:
1. All lines and grade work not presently established at the site shall be laid out by the Engineer/Surveyor in accordance with the Drawings and Specifications. Establish permanent bench marks necessary for the work under this Contract. Maintain all established bounds and bench marks and replace as directed at no expense to the Owner any that are destroyed or disturbed.
 2. Establish all lines and grades for the work and verify all locations, property lines, work lines, and other dimensioned points indicated on the Contract Drawings for the existing site.
 3. Submit to the Engineer, a written confirmation of locations of all lines, and any discrepancies between conditions and locations as they actually exist and those indicated on the Contract Drawings. Such confirmation shall bear the registration stamp of the Engineer/Surveyor.
- B. Do not commence any excavation or construction work until verification of the layout performed by the Engineer/Surveyor has been received and approved by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Common Fill: Excavated soil material obtained from the construction site, if available, or imported material free from roots and other organic material, wood, trash, broken rock or stones in excess of 8-inches in diameter and with a percent passing the number 200 sieve of not greater than 30, and other approved granular soil suitable for use as general fill by the Engineer. Such material shall not possess physical properties that inhibit the placement or function of the fill, including being oversaturated.
- B. Structural Fill: Well-graded, select angular excavated gravel or processed stone materials free of organic material, loam, trash, snow, ice, frozen soil, and other objectionable material. Such material shall have characteristics that promote efficient compaction, provide a stable and predictable bearing surface, and conform to the gradation requirements as follows:

<u>Sieve Size</u>	<u>% Passing (by weight)</u>
6"	100%
1"	60-100%

No. 4	35-85%
No. 10	25-75%
No. 20	15-60%
No. 40	10-45%
No. 100	5-25%
No. 200	3-10%

On-site excavated material may be suitable for use as structural fill if it conforms to the specifications noted and is approved for use by the Engineer. Reuse will require the removal of unsuitable materials prior to reuse and may require blending with coarser imported granular soil material to achieve the required gradation.

- C. If reclaimed miscellaneous aggregate or soil fill is proposed to be used as any type of fill material, the material shall be tested to confirm the material meets or exceeds the requirements for "clean fill" in accordance with the State of Connecticut DOT Form 816, the Regulations of Connecticut State Agencies (RCSA), and the Department of Environmental Protection (DEP).
- D. Crushed Stone Fill: broken stone or gravel conforming to the requirements of Section M.02.06 for Course Aggregate, as described in the State of Connecticut DOT Form 816, with gradation for A as follows:

<u>Sieve Size</u>	<u>% Passing (by weight)</u>
3-1/2"	100%
1-1/2"	55-100%
1/4"	25-60%
No. 10	15-45%
No. 40	5-25%
No. 100	0-10%
No. 200	0-5%

- E. Processed Aggregate Fill: Processed Aggregate for use beneath structures, concrete slabs, and asphalt pavements (and where shown or specified below and around structures) shall be crushed aggregate conforming to the ConnDOT Form 816 requirements for M.05.01.
- F. Pipe Bedding Fill: Fill for use in direct contact below, around, and above new buried utilities shall consist of a granular sand with no stones greater than one inch and not more than 10 percent passing the #200 sieve. Stones present shall be rounded or sub-angular.
- G. Trenching Fill: Trenching fill placed below roadways or sidewalks may consist of compacted Common Fill to a depth of not less than 6 inches below the utility structure. Trenching fill placed below footings or slabs must consist of compacted Structural Fill or compacted Crushed Stone to a depth of not less than 6 inches below the utility structure. Fill above bedding fill used in utility trench installations shall consist of

either: compacted Structural Fill or compacted Crushed Stone in areas where utilities are placed below footings or slabs, or compacted Common Fill below roadways, sidewalks, aprons, or other non-structural areas.

- H. Filter Fabric: Conform to State of Connecticut Form 816, Section M.08.01, Paragraph 26, Mirafi 140 Filter Fabric, or approved equivalent.
- I. Vapor Retarder:
 - 1. Vapor Retarder must have the following qualities
 - a. WVTR less than or equal to 0.006 gr/ft²/hr as tested by ASTM E 96
 - b. ASTM E 1745 Class A (Plastics)
 - 2. Vapor Retarder Products
 - a. Stego Wrap (15-mil) Vapor Barrier by Stego Industries, LLC, San Juan Capistrano, CA (877) 464-7834 www.stegoindustries.com, or approved equivalent.
 - 3. Accessories:
 - a. Vapor Retarding Seam Tape
 - 1. Tape must have the following qualities:
Water Vapor Transmission Rate of 0.3 perms or lower by ASTM E 96
 - b. Vapor Proofing Mastic
 - 1. Mastic must have the following qualities:
Water Vapor Transmission Rate of 0.3 perms or lower by ASTM E 96
 - c. Pipe Boots
 - 1. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.
- J. Topsoil: refer to Section 32 92 00, Turf and Grasses.

PART 3 - EXECUTION

3.1 GENERAL EXCAVATION REQUIREMENTS

- A. Locate existing underground utilities in areas of excavation work. Properly notify "Call Before You Dig" prior to excavation. Provide adequate means of support and protection during earthwork operations.
- B. Provide adequate notice to Owner, and receive written notice to proceed before interrupting any utility. Cooperate with Owner and utility companies in keeping respective services and facilities in operation, as may be applicable.
- C. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.

- D. Demolish and completely remove from site existing pavement, sidewalks, underground utilities, and other features specifically indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
- E. Should uncharted, or incorrectly charted piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Repair damaged utilities to satisfaction of utility Owner.
- F. Use of explosives: do not bring explosives onto site or use in work without prior written permission from authorities having jurisdiction.
- G. Maintenance of Site Safety: place warning flagging and/or construction fencing around the construction area and specifically barricade open excavations occurring as part of this work that are greater than 3 feet deep using at least a 5-foot high snow fence around the top of the excavation for protection against unauthorized access. The barricade should be positioned at least 1.5 times the depth of the excavation away from the bottom of the excavation.
- H. Protect existing foundations, benchmarks, utilities, sidewalks, pavements, curbs, and other facilities or structures from damage caused by settlement, lateral movement, undermining, vibrations, washout, sedimentation, and other hazards created directly or indirectly by earthwork operations.
- I. Store construction materials in a safe manner that does not increase the risk to safety of workers or the public, or cause potential harm to other materials, structures, or property.
- J. Provide necessary safeguards to prevent accidents, to avoid all necessary hazards, and to protect the public, the work, and the property at all times, including Saturdays, Sundays, and holidays.
- K. Carefully layout the limits of work to avoid damage to areas not intended to be part of the excavation activities.
- L. Be responsible for any and all damages which may arise or occur to any party whatsoever by reason of the neglect in providing proper lights, guards, barriers, or any other safeguards to prevent damage to property, life, and limb.
- M. Where existing topsoil lies within the footprint of areas to be excavated, segregate and stockpile the material for future use during landscaping, as directed by the Engineer.

3.2 ROCK EXCAVATION

- A. Excavate rock within the boundary lines and grades as shown, specified or required.

1. Rock removed from the excavation becomes the property of the Contractor. Transportation and disposal of the excavated rock to an off-site disposal location and shall be the responsibility of the Contractor.
2. Remove rock in a manner that minimizes disturbance to intact rock not designated for removal. Stabilization of rock that is disturbed beyond the limits of the work in structurally bearing areas shall be performed by the Contractor at its own expense, as requested by the Engineer.

3.3 STABILITY OF EXCAVATIONS

- A. General: comply with all codes, ordinances, and requirements of agencies having jurisdiction. Inspect and manage excavations in accordance with Section 31 50 00, Excavation Support and Protection.
- B. Excavations of at least 5 feet in depth will be required for the new work. Sloped sides of excavations must comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Inspect and maintain sides and slopes of excavations to assure safe conditions until completion of backfilling. Cover slopes to prevent weakening by precipitation. Do not overload the tops of slopes with fill, other materials, or equipment.
- C. Backfill all sloped and shored trenches and excavations within the building footprint and perimeter as soon as soon as practicable, completely, and in a controlled manner to assure proper support of new structures.

3.4 DEWATERING

- A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area by implementing proper water removal systems, diversions, and erosion and sedimentation controls.
- B. Do not allow water to accumulate in excavations. Control water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Maintain groundwater at least two feet below excavations during earthwork activities. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations at no additional expense to Owner. Operate such systems continuously, as may be needed, until backfilling is complete.
- C. Establish and maintain temporary sumps, drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to proper, authorized collecting, infiltration, or runoff areas. Do not use trench excavations created for new structures as temporary drainage ditches.

3.5 STORAGE OF EXCAVATED MATERIALS

- A. Stockpile excavated materials acceptable for possible reuse as fill where directed. Place, grade, and shape stockpiles for proper drainage and in a manner that prevents erosion and sedimentation. Keep materials suitable for reuse separate from unsuitable materials.
- B. Locate and retain soil materials safely away from edge of excavations.
- C. Legally load, transport, and dispose of excess excavated soil material and materials not acceptable for use as fill off site.

3.6 EXCAVATION FOR STRUCTURES

- A. For all excavations, allow sufficient notice and access for inspection and approval of subgrades by the Engineer.
- B. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services and other construction, safe work practices, and inspection.
- C. During excavations for footings and foundations, minimize unnecessary disturbance of bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed when necessary to remove disturbed surface soils. Trim bottoms to required lines and grades to leave solid base to receive other work.
- D. The bottom of all exterior footings shall be at least 42 inches below finished exterior grade. The Contractor shall be responsible for the coordination of the bottom of exterior footing elevations with the finish grades to achieve the 42 inch burial depth for frost protection.
- E. Excavation for underground tanks, basins, and mechanical or electrical structures: conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot: plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavation intended for bearing surface.
- F. Excavation for pipes and conduits: conform to elevations and lateral dimensions indicated within a tolerance of plus or minus 0.10 foot. Install bedding below and above structures to form a stable and uniform support environment, and conduct backfilling in accordance with Section 3.9.

- G. Rock surface preparation: in areas where Rock excavation is required, prepare all Rock surfaces prior to backfill or foundation construction. Remove all shattered rock and loose pieces from the excavation bottom. Fill voids in the bedrock surface with crushed stone or lean concrete such that a clean, level surface is prepared. Excavate rock such that the prepared rock subgrade slopes not greater than 0.2 foot vertical per foot horizontal.

3.8 COLD WEATHER PROTECTION

- A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- B. Protect bottom of excavations and soil around and beneath foundations from frost.
- C. If necessary, insulate backfill materials to prevent the formation of frozen clods that would otherwise render the backfill unusable.

3.9 BACKFILL AND FILL

- A. General: place acceptable soil structural and non-structural fill material in controlled, horizontal layers to required elevations.
- B. Under footings, slabs, sidewalks, aprons, pavements, and other structures, use Structural Fill as required. Use Structural Fill as backfill above utilities in areas that are load bearing. Where backfill is required below sidewalks, aprons or pavements to reach subgrade elevations, Common Fill may be placed to a minimum 12 inches below the structures.
- C. Under footings in areas of rock excavations, use Crushed Stone or Structural Fill.
- D. Although not anticipated, in areas where Crushed Stone is placed in a total layer thickness greater than 8 inches and adjacent to soil that may have the potential to be saturated, rap Crushed stone with Filter Fabric.
- E. Against wall structures where a footing drain is provided, use only well-draining gravelly or coarse sandy soil as backfill. Common fill may be used against wall structures that do not function as basement walls.
- F. Directly under, around, and above piping, conduit and equipment, install Pipe Bedding Fill.
- G. At perforated drain piping, surround pipe with a minimum 6-inch radius of washed crushed stone fill enveloped in non-woven filter fabric.

- H. Backfill trenches with concrete where trench excavations pass under wall footings or within 18 inches laterally of column or wall footings and lower in elevation than the bottom of such footings. Ensure trenching does not interfere with normal 45 degree bearing zone splay of any foundation. Place concrete to level of bottom of adjacent footing. Special consideration may be required for pipes larger than 8 inches in diameter.
- I. Backfill unauthorized excavation as follows:
 - 1. Under footings, foundation bases, loading dock walls or retaining walls, fill unauthorized excavation by placing compacted Structural Fill or Crushed Stone from base of the excavation to indicated bottom elevation of footing or base.
 - 2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by the Engineer.
- J. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Subgrade is prepared and compacted to receive backfill.
 - 2. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, under slab and foundation drainage, and perimeter insulation.
 - 3. Inspection, testing, approval, and recording locations of underground utilities.
 - 4. Removal of concrete formwork.
 - 5. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
 - 6. Removal of trash and debris from excavation.
 - 7. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.10 PLACEMENT AND COMPACTION

- A. For slab-on-grade areas, proof-roll exposed, approved ground surfaces with a ten ton vibratory roller, or rubber-tired equipment with a minimum body weight of 60,000 pounds prior to placement of required fill.
- B. Place fill materials in layers not more than 12 inches in loose thickness for material compacted by heavy compaction equipment, and not more than 6 inches in loose thickness for material compacted by hand-operated tampers.
- C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are covered by standing water, muddy, frozen, or contain frost or ice.

- D. Place fill materials evenly adjacent to foundations or other structures to required elevations. Prevent wedging action of fill against structures by carrying material uniformly around structures to approximately same elevation in each lift, including filling evenly against inside and outside of structures to avoid unbalanced lateral loads for structures not designed for such conditions.
- E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Where on-site soils are reused, Contractor must be prepared to devote the appropriate amount of effort to manage the moisture content of the material, install the material at a moisture content that is as close as possible to optimum, and completely compact each lift, even if thinner than normal lifts are necessary, to break up any clods of fine-grained material and prevent the burial of voids.
- F. Correct improperly compacted areas or lifts as directed by Engineer if soil density tests indicate inadequate compaction.
- G. Percentage of maximum density requirements: compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
 - 1. Under and within 5 feet of footings, building slabs, structures, and in trenches and isolated pads, compact top 12 inches of soil subgrade and each layer of fill material to 95% maximum density.
 - 2. For exterior backfill of wall structures (not inside structures) where surface features will not be present requiring structural support, compact each layer of fill material to a minimum of 90%, but not more than 92% of maximum density.
 - 3. For exterior backfill of wall structures where surface features will be present, such as aprons, stairs, or sidewalks, compact each layer of fill material to a minimum of 95% maximum density.
 - 4. Under pavements and sidewalks, install each layer of fill material to 95% maximum density.
 - 5. In landscaped areas, compact top 6" of subgrade and each layer of fill material to 90% of maximum density.
- H. Moisture control: where the subgrade or a layer of soil material must be moisture-conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations. Temporarily cover stockpiles of intended backfill with plastic sheeting to prevent the materials from becoming oversaturated during precipitation events.
- I. At no additional expense to Owner, remove and replace, or scarify and air dry, intended backfill soil material that was not protected from precipitation and is too wet to permit compaction to specified density. Similarly, remove and replace, or scarify and air dry, intended backfill soil material that was delivered to the site at a moisture content too high to permit compaction.

3.11 GRADING

- A. General: The Drawings indicate finished elevations. The grading to be performed consists of establishing finished grade elevations as shown on the Drawings. The Contractor shall import additional materials if on-site quantities and/or qualities are insufficient and/or shall dispose of excess materials off-site as required at no additional cost to the Contract Sum.
- B. Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
- C. Finish surfaces free from irregular surface changes, and as follows:
 - 1. Landscaped areas: finish areas to receive topsoil to within not more than 0.10 feet above or below required subgrade elevations.
 - 2. Walks: shape surface of areas under walks to line, grade and cross section, with finish surface not more than 0.04 feet above or below required subgrade elevation.
 - 3. Pavements: shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 0.04 feet above or below required subgrade elevation.
 - 4. Grading surface of fill under slabs: grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 0.04 feet when tested with a 10-foot straightedge. Grade to maintain the specified thickness of gravel fill and crusher run aggregate.
- D. Compaction: after grading, compact subgrade surfaces to the depth and indicated percentage of maximum density for each area classification.

3.12 TOPSOIL SPREADING AND FINE GRADING

- A. Refer to Specification Section 32 92 00.

3.13 FIELD QUALITY CONTROL

- A. Subgrade verification: notify the Engineer at minimum 10 days prior to footing and slab subgrade preparation. The Engineer shall be provided with the opportunity to observe all footing and slab excavations upon completion of excavation or overexcavation, and prior to placement of fill, in order to verify acceptable subgrade conditions. This will be particularly important to verify whether certain existing materials are acceptable as bearing subgrades. Perform additional overexcavation of unsuitable soils or additional subgrade preparation measures at the direction of the Engineer.

- B. Quality control testing during construction: allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
- C. If, in opinion of the Engineer, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained at no additional cost to the Contract Sum.

3.14 MAINTENANCE

- A. Protection of graded areas: protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning compacted areas: where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- D. Settling: where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add fill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from Owner's property: remove waste materials, including unsuitable material, excess excavated material, trash, and debris, and dispose of it legally off Owner's property.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 31 21 00

ROCK AND BOULDER EXCAVATION

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall furnish all labor, materials, equipment, and incidentals required and excavate and dispose of rock and boulders as shown on the Drawings and as specified herein.
 - 2. Blasting will not be permitted on this project.
- B. Related Sections:
 - 1. Section 312000, Earth Moving.

1.2 SUBMITTALS

- A. Submit the proposed methods of excavation for the various portions of the work. Submittals shall be for information only. CONTRACTOR shall remain responsible for means, methods and techniques, as well as all safety considerations.

1.3 DEFINITIONS

- A. Rock: Any large mass of stone, bedrock, or ledgerock.
- B. Boulder: Rock fragments exceeding 1 cu yd in volume.
- C. Rock Excavation: The removal of solid rock or rock fragments greater than 1 cu yd in volume which cannot be removed by conventional mechanical excavation equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ROCK EXCAVATION

- A. Rock excavation may be performed by jackhammering, expansive chemical splitting, or other similar process.

3.2 BOULDER EXCAVATION

- A. Boulders and rock fragments up to 1 cu yd in volume may be reduced in size by rock excavation methods to simplify its removal.

3.3 DISPOSAL OF ROCK AND BOULDERS

- A. Fragmented rock up to 12 inches in length in any direction may be used as riprap or slope stabilization, provided that such materials meet the requirements for riprap and slope stabilization specified.
- B. Rock and boulders may be crushed and screened for reuse in the work, provided that the resultant materials meet the requirements for gravel as specified in Section 312000, Earth Moving.
- C. Unused rock and boulders greater than 12-inches in length in any direction shall be removed and disposed of off site.

+ + END OF SECTION + +

SECTION 31 10 00

SITE CLEARING

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes construction dewatering.

1.2 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1.3 SUBMITTALS

- A. Shop Drawings for Information: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.
 - 1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

- A. A.Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. 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.

3.2 INSTALLATION

- A. 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.

- B. 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. 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. 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 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.

+ + END OF SECTION + +

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes temporary excavation support and protection systems.

1.2 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. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.

1.3 SUBMITTALS

- A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.
 - 1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 PROJECT CONDITIONS

- A. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; 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

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36, ASTM A 690, or ASTM A 992.

- C. Steel Sheet Piling: ASTM A 328, ASTM A 572, or ASTM A 690; with continuous interlocks.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 3 inches.
- E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- F. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

PART 3 - EXECUTION

3.1 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.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- C. 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.
- D. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 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. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
 - 2. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

+ + END OF SECTION + +

SECTION 32 12 16

ASPHALT PAVING

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes asphalt paving and patching, bituminous concrete lip curb, and painted pavement markings.

1.2 SUBMITTALS

- A. Product Data: Submit for each type of product indicated. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Material certificates.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B. Regulatory Requirements: Comply with local authorities having jurisdiction asphalt paving work.
- C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.
- D. Connecticut Department of Transportation (ConnDOT): Standards Specifications for Roads, Bridges and Incidental Construction (Form 816); Dated 2004

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
 - 1. Tack Coat: Minimum surface temperature of 60 deg F.
 - 2. Asphalt Binder Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Bituminous Prime Coat: Grade MC 70 cut back asphalt conforming to ConnDOT Specifications Form 816, Section M.04.01.
- B. Bituminous Concrete: Materials and mix shall be in accordance with ConnDOT Specifications, Form 816, Section M.04.01 and Section M.04.02 for Class 1 and Class 2 Mixtures. Asphalt Cement shall be AC 20 viscosity grade conforming to AASHTO M226.
- C. Mix Plant: Shall conform to AASHTO M156.
- D. Tack Coat: Emulsified asphalt; AASHTO M 140 (ASTM D 977) or M208 (D 2397); SS-1, SS-1h, CSS-1, CSS-1h, diluted with one part water to one part emulsified asphalt.
- E. Bituminous Concrete Lip Curbing: Conform to the Standard Specifications Form 816, Section M.04.01, and Section M.04.02 for Class 3 mixture.
- F. Painted Pavement Markings: Conform to the Standard Specifications Form 816 Section 12.10 for epoxy resin pavement markings.

PART 3 - EXECUTION

3.1 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

3.2 SURFACE PREPARATION

- A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
 - 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Spread mix at minimum temperature of 250 deg F.
 - 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for

indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: Ninety-two percent (92%) of reference maximum theoretical density according to ASTM D 2041, but not less than ninety percent (90%) nor greater than ninety-six percent (96%).
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- F. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus $\frac{1}{2}$ inch.
 - 2. Surface Course: Plus $\frac{1}{4}$ inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: $\frac{1}{4}$ inch.
 - 2. Surface Course: $\frac{1}{8}$ inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is $\frac{1}{4}$ inch.

3.6 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
- B. Allow paving to age for thirty (30) days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.8 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 32 13 13

CONCRETE PAVING

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Concrete stairs, ramps, sidewalks, curbs, and aprons.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete pavement mixture.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94 requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets, galvanized finish.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- C. Reinforcing Bars: ASTM A 615, Grade 60; deformed.
- D. Plain Steel Wire: ASTM A 82, as drawn.
- E. Deformed-Steel Wire: ASTM A 496.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I/II, white. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4M coarse aggregate, uniformly graded. Provide aggregates from a single source.
- C. Water: ASTM C 94.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: ASTM C 494, of type suitable for application, certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.3 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

2.4 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

2.5 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
 - 1. Compressive Strength (Twenty-Eight (28) Days): 4000 psi (min.) or as otherwise required.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch.
 - 4. Air Content: Four and one-half percent (4.5%) plus or minus one and one-half percent (1.5%).

2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94 and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least twenty-four (24) hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated

- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.
 - 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Isolation (Expansion) Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 20 feet unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than ½ inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one (1) length is required, lace or clip joint-filler sections together.
 - 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction (Control) Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness.
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a ¼-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - 2. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a ¼-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed pavement surfaces with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 - 2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 - 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these methods.

3.8 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Protect concrete from damage. Exclude traffic from pavement for at least fourteen (14) days after placement.
- C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two (2) days before date scheduled for Substantial Completion inspections.

++ END OF SECTION ++

SECTION 32 92 00

TURF AND GRASSES

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Hydroseeding.
 - 3. Sodding.
 - 4. Erosion-control material(s).
- B. Related Sections:
 - 1. Section 31 10 00, Site Clearing for topsoil stripping and stockpiling.
 - 2. Section 31 20 00, Earth Moving for excavation, filling and backfilling, and rough grading.

1.2 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. 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.
- F. 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.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. 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.

1.3 ACTION 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- D. Material Test Reports: For existing native surface topsoil and imported or manufactured topsoil.

1.5 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 Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in turf installation.
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's personnel assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation maintenance irrigation specialty areas, designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and

capability to conduct the testing indicated and that specializes in types of tests to be performed.

- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
 - 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 - 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Engineer. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 - 3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: 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.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.7 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 Substantial Completion.
 - 1. Spring Planting: April 15 to June 15
 - 2. Fall Planting: August 15 to November 30

- B. 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.

PART 2 - PRODUCTS

2.1 SEED

- A. Seed Species: State-certified seed of grass species as follows:
- B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 - 2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 - 3. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
- G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
- D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.4 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.5 PLANTING SOILS

- A. Planting Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 1. Supplement with imported planting soil when quantities are insufficient.

2.6 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.7 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.

2.8 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.

PART 3 - EXECUTION

3.1 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. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

3.2 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 hydroseeding 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.

3.3 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. 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.
- B. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.4 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 recommended by manufacturer.
- 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 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

- E. Protect seeded areas with slopes not exceeding 1:6 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.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with asphalt-emulsion tackifier.
 - 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 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.6 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.

3.7 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 to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

+ + END OF SECTION + +

SECTION 33 05 05

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections.
 - b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
 - c. Work on or affecting existing buried piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
 - e. Supports, restraints, and thrust blocks.
 - f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
 - g. Field quality control, including testing.
 - h. Cleaning and disinfecting.
 - i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Process Integration.

C. Related Sections:

1. Section 31 20 00, Earth Moving.
2. Section 03 30 05, Concrete.
3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ASME Boiler and Pressure Vessel Code.
2. ASME B31.3, Process Piping.
3. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
4. ASTM B32, Specification for Solder Metal.
5. ASTM C12, Practice for Installing Vitrified Clay Pipe Lines.
6. ASTM C425, Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
7. ASTM C828, Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.
8. ASTM C924, Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Test Method.
9. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
10. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
11. ASTM D4174, Practice for Cleaning, Flushing and Purification of Petroleum Fluid Hydraulic Systems.
12. ASTM F1417, Test Method for Installation Acceptance of Plastic Gravity Sewer Lines using Low-Pressure Air.
13. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.
14. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
15. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
16. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
17. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
18. ANSI/AWWA C603, Installation of Asbestos-Cement Pressure Pipe.
19. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
20. ANSI/AWWA C606, Grooved and Shouldered Joints.
21. ANSI/AWWA C651, Disinfecting Water Mains.
22. AWWA M9, Concrete Pressure Pipe.
23. AWWA M11, Steel Water Pipe - A Guide for Design and Installation.
24. AWWA M23, PVC Pipe - Design and Installation.
25. AWWA M41, Ductile-Iron Pipe and Fittings.
26. AWWA M45, Fiberglass Pipe Design.
27. AWWA M55, PE Pipe - Design and Installation.
28. ASCE 37, Design and Construction of Sanitary and Storm Sewers.
29. American Concrete Pipe Association, Concrete Pipe Handbook.
30. Chlorine Institute, Inc., Piping Systems for Dry Chlorine, Pamphlet No. 6.

31. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.
 2. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Laying schedules for concrete pipe and piping with restrained joints.
 - b. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
 2. Product Data:
 - a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
 3. Testing Procedures:
 - a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER's approval prior to commencing testing.
- B. Informational Submittals: Submit the following:
 1. Certificates:
 - a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
 2. Field Quality Control Submittals:
 - a. Results of each specified field quality control test.
- C. Closeout Submittals: Submit the following:
 1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
 - b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
 - c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
 - d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 - 2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.
- B. Storage:
 - 1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
 - 2. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.
- C. Handling:
 - 1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
 - 2. Avoid unnecessary handling of pipe.
 - 3. Keep pipe interiors free from dirt and foreign matter.
 - 4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 40, Process Integration.
- B. General:
 - 1. Pipe Markings:
 - a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.
- C. Polyethylene Encasement:
 - 1. Polyethylene may be supplied in tubes or sheets.
 - 2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

2.2 BURIED PIPING IDENTIFICATION

- A. Polyethylene Underground Warning Tape for Metallic Pipelines:
1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
 2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
 3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products
 - c. Marking Services, Inc.
 - d. Or equal.
- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
 2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.
 3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products
 - c. Marking Services, Inc.
 - d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
 2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.

3. ENGINEER will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify ENGINEER in advance of excavating, bedding, pipe laying, and backfilling operations.
4. Minimum cover over buried piping shall be 4 feet, unless otherwise shown or approved by ENGINEER.
5. Earthwork is specified in Section 31 20 00, Earth Moving.
6. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted in accordance with Section 31 20 00, Earth Moving .

B. Separation of Sewers and Potable Water Piping:

1. Horizontal Separation:
 - a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
 - b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.
 - c. Exception:
 - 1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
2. Vertical Separation:
 - a. Provide minimum vertical distance of 18 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
 - b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.
 - c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
 - d. Exceptions:
 - 1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
 - 2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

C. Plugs:

1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.

D. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.

1. Trench excavation and backfill, and bedding materials shall conform to Section 31 20 00, Earth Moving, as applicable.
2. Where ENGINEER deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with Section 31 20 00, Earth Moving.
3. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.
4. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
5. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
6. Do not lay pipe until ENGINEER approves bedding condition.
7. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

E. Laying Pipe:

1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
 - b. Concrete Pipe: AWWA M9.
 - c. Steel Pipe: ANSI/AWWA C206, AWWA M11.
 - d. Thermoplastic Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA M45, AWWA, M55.
 - e. Vitrified Clay Pipe: ASTM C12.
 - f. Sanitary and Storm Sewers: ASCE 37.
2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
3. Slope piping uniformly between elevations shown.

4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by ENGINEER.
7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in vertical position.
8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.
10. For PVC and CPVC piping with solvent welded joints, 2.5-inch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
13. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.
15. Touch up protective coatings in manner satisfactory to ENGINEER prior to backfilling.
16. Notify ENGINEER in advance of backfilling operations.
17. On steep slopes, take measures acceptable to ENGINEER to prevent movement of pipe during installation.
18. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
19. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

F. Polyethylene Encasement:

1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.
2. Polyethylene encasement installation shall be in accordance with ANSI/AWWA C105.

G. Jointing Pipe:

1. Ductile Iron Mechanical Joint Pipe:

- a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
- b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
- c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
- d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
- e. Push gland toward socket and center gland around pipe with gland lip against gasket.
- f. Insert bolts and hand-tighten nuts.
- g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

- h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.
- i. Restrained mechanical joints shall be in accordance with Section 40 05 19, Ductile Iron Process Pipe.

2. Ductile Iron Push-On Joint Pipe:

- a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.
- b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
- c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
- d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.

- e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.
 - f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.
3. Ductile Iron Proprietary Joints:
- a. Install pipe that utilizes proprietary joints for restraint specified in Section 40 05 19, Ductile Iron Process Pipe, or other such joints, in accordance with manufacturer's instructions.
4. Prestressed Concrete Cylinder Pipe Joints:
- a. Immediately before making the joint, completely clean bell and spigot surfaces to be jointed.
 - b. Apply lubricant supplied by pipe manufacturer to sealing surfaces of bell, spigot, and gasket. After lubrication, install gasket in spigot groove and ensure that stretch in the gasket is equalized.
 - c. After pipe is lowered into place, align spigot and bell so that spigot will squarely enter the bell.
 - d. Before joint is fully assembled, check position of gasket in bell using methods recommended by pipe manufacturer and accepted by ENGINEER.
 - e. If gasket is in correct position around entire circumference of the bell, remove temporary joint stoppers, if used, and insert pipe completely into bell. If gasket is not in proper location, open the joint and reinstall using a new gasket.
 - f. Where joint opening is required to make grade or alignment adjustment, joint shall first be installed completely closed, then opened as necessary on one side. Joint openings shall not be greater than 75 percent of maximum opening recommended by pipe manufacturer.
 - g. Strap diaper to outside of completed joint, straddling the external joint recess. Pour grout mix consisting of portland cement and sand in proportions recommended by pipe manufacturer to completely fill external joint recess. In lieu of joint diaper, CONTRACTOR may, with written approval of pipe manufacturer, use polyurethane foam joint protector with unhydrated portland cement dispersed throughout protector. Protector shall have the cross-sectional shape required for the type of joint being installed and shall be formed in loop to fit size of pipe on which it is to be used.
 - h. Point interior joint recess of pipe 24-inch nominal diameter and larger with portland cement/sand mortar mixed in proportions recommended by pipe manufacturer. Strike off grout smooth with interior face of pipe. For pipes that convey sewage or non-potable water, interior surfaces of

steel joint ring shall be protected by butyl rubber mastic joint filler, supplied or recommended by pipe manufacturer, applied to bell socket just prior to joining the pipe such that mastic squeezes out to fill internal joint recess.

- i. Coat exterior exposed steel portions of pipe, flanges, couplings, bolts and nuts with two coats each eight-mils minimum dry film thickness, of high-build epoxy or bituminous coating manufactured by Tnemec, or equal.
- j. Maintain sufficient quantity of joint lubricant, gaskets, joint diapers, and joint fillers at the Site at all times.
- k. Do not use gaskets that have been scored or otherwise damaged.
- l. Where welded joints are required to handle thrust, steel spigot shall be cut at trailing edge of gasket groove to provide surface suitable for field-welding. Field-welded joints shall be full circumferential welds designed to take thrust at joint location. Provide minimum 3/16-inch weld. Exposed steel surface of pipe joints shall have temporary protection system of rust and corrosion inhibitor applied that need not be removed prior to welding. After welding is complete, joint protection shall be completed with interior and exterior cement mortar grouting.

5. Steel Pipe Joints:

- a. Joints in steel pipe shall be bell and spigot when so specified for steel water pipe in accordance with AWWA C200, or butt welded or lap welded joints, except that mechanical couplings, or flanged connections shall be provided at connections to valves, meters, and similar equipment, and where shown or indicated in the Contract Documents. Mechanical couplings are specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.
- b. Welding shall conform to ANSI/AWWA C206. When butt-welding or lap welding joints, weld pipe 36-inch diameter and larger both inside and outside of pipe.
- c. Field welded lap joints shall have fillet welds both inside and outside. Outside weld may be seal weld.
- d. After welding, coat the joint and surrounding damaged or uncoated area with same coating and thickness as shop-applied coating.
- e. Where flanged connections or couplings are provided, flanges, couplings, bolts, and nuts, except when stainless steel, shall be coated with two coats, minimum dry film thickness of eight-mils each, of high-build epoxy or bituminous coating manufactured by Tnemec, or equal.
- f. Welds shall be free from embedded scale and slag and shall have tensile strength across weld not less than thinnest of connected sections.
- g. Welds shall be watertight.
- h. Provide cathodic protection at steel pipe joints as specified in this Section.

6. Thermoplastic Pipe Joints:

- a. Solvent Cement Welded Joints:
 - 1) Bevel pipe ends and remove all burrs before making joints. Clean pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement

- welded joints in wet conditions.
- 2) Use solvent cement supplied or recommended by pipe manufacturer.
 - 3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
 - 4) Take appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.
- b. Bell and Spigot Joints:
- 1) Bevel pipe ends, remove all burrs, and provide a reference mark at correct distance from pipe end before making joints.
 - 2) Clean spigot end and bell thoroughly before making the joint. Insert O-ring gasket while ensuring that gasket is properly oriented. Lubricate spigot with manufacturer's recommended lubricant. Do not lubricate bell and O-ring. Insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.
7. Vitrified Clay Pipe Joints:
- a. Use compression-type joints conforming to ASTM C425 for vitrified clay pipe.
 - b. Clean joint contact surfaces immediately prior to jointing. Use lubricants, primers, or adhesives recommended by pipe or joint manufacturer.
8. Copper Tubing Joints:
- a. Soldered Joints:
 - 1) Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.
 - 2) Ream or file pipe to remove burrs.
 - 3) Clean and polish contact surfaces of joints.
 - 4) Apply flux to both male and female ends.
 - 5) Insert end of tube into full depth of fitting socket.
 - 6) Heat joint evenly.
 - 7) Form continuous solder bead around entire circumference of joint starting at the bottom.
 - b. Threaded Joints:
 - 1) When open flames for soldering are impractical, or at unions and connections to equipment and appurtenances, assemble copper tubing with flared ends as permitted by authority having jurisdiction.
 - 2) Ends of tubing shall be flared at an angle of 45 degrees with flaring tool recommended by pipe manufacturer. Flaring tool shall have same outside diameter as tube to be flared.
 - 3) Tubing to be flared shall be soft temper or annealed prior to flaring.
 - 4) End of tube shall be cut square and reamed to remove burrs.
 - 5) Tube that is out-of-round shall be resized back to round.
 - 6) Clean and polish contact surfaces of joints using an abrasive cloth.
 - 7) Place flare nut over the end of tube with threads closest to end being flared.

- 8) Insert appropriate length of tube between flaring bar of flaring tool and position the yolk with flaring cone over tube end and clamp yoke in place.
 - 9) Turn handle of yolk clockwise without over-tightening. Cracked or deformed tubes will be rejected.
 - 10) Do not apply jointing compounds to mating surfaces of flare fitting and flared tube end before attaching flare nut to threaded connection.
9. Mechanical Coupling Joints:
- a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.
 - b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.
 - c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
 - d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove clamps from coupling. Slide coupling over plain ends of pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with torque wrench to torque recommended by manufacturer.
10. HDPE Pipe Joints:
- a. Bell and Spigot Joints:
 - 1) Remove all burrs and provide reference mark at correct distance from pipe end. Place mark such that no more than 1/2-inch of machined spigot surface will be visible outside of bell after pipe has been joined.
 - 2) Clean spigot end and bell thoroughly with soap and water before positioning gasket.
 - 3) Lubricate spigot groove with manufacturer's recommended lubricant. Thoroughly clean gasket and place in spigot groove starting at bottom, ensuring that gasket fins face backwards toward pipe.
 - 4) Thoroughly lubricate gasket with pipe manufacturer's recommended lubricant and equalize stretch in gasket by running screwdriver under gasket around its entire circumference three times. Reposition gasket in groove after stretching.
 - 5) Thoroughly clean and lubricate receiving bell. Align pipe as straight as possible and insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.
 - 6) If mechanical means are used to insert spigot end, protect with wood

the end of pipe being pushed, to ensure even distribution of pressure.

b. Butt Fusion Welded Joints:

- 1) Install joints in accordance with manufacturer's instructions using hydraulic butt fusion machine or manual machine equipped with torque wrench. Equipment shall be able to achieve and maintain heating tool temperature range of 400 to 450 degrees F and an interface pressure of 60 to 90 psi.
- 2) Clean interior and exterior of pipe and fitting ends with clean, dry, lint-free cloth.
- 3) Align ends to be joined in the fusion machine without forcing ends into alignment. Adjust alignment as necessary and tighten clamps to prevent slippage.
- 4) Place facing tool between ends to be joined and face them to provide clean, smooth, parallel mating surface. If stops are present, face ends down to the stops. Remove all shavings after facing without touching ends.
- 5) Re-check alignment of ends and check for slippage against fusion pressure. There shall be no detectable gaps between ends. Align outside diameters.
- 6) Heating tool shall maintain pipe manufacture's recommended temperature range. Place the tool between ends to be joined. Move ends against heating tool to achieve full contact. Hold ends against heating tool without force until the following melt bead size is formed:

Pipe Diameter (inches)	Required Melt Bead Size (inches)
2 to 4	1/8 to 3/16
4 to 12	3/16 to 1/4
12 to 24	1/4 to 7/16
24 to 54	7/16 to 9/16

- 7) Upon forming proper melt bead size, quickly separate ends and remove heating tool. Quickly inspect melted ends and bring ends together applying joining force recommended by manufacturer, using 60 to 90 psi interfacial pressure to form double bead rolled over surface of pipe on both ends.
- 8) Hold joining force against ends until joint is cool to the touch. Cooling period shall be 30 to 90 seconds per inch of pipe diameter. Heavier wall thicknesses may require longer cooling times as recommended by pipe manufacturer.
- 9) Upon completing joint, inspect to verify double bead has been formed on both sides, uniformly rounded and consistent in size all around joint. Remove faulty joints and re-joint.

I. Backfilling:

1. Conform to applicable requirements of Section 31 20 00, Earth Moving.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

- J. Connections to Valves and Hydrants:
 - 1. Install valves and hydrants as shown and indicated in the Contract Documents.
 - 2. Provide suitable adapters when valves or hydrants and piping have different joint types.
 - 3. Provide thrust restraint at all hydrants and at valves located at pipeline terminations.
- K. Transitions from One Type of Pipe to Another:
 - 1. Provide necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.
- L. Closures:
 - 1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

- A. Polyethylene Underground Warning Tape for Metallic Pipelines:
 - 1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
 - 2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
 - 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
 - 4. Tape shall be spread flat with message side up before backfilling.
- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
 - 1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
 - 2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
 - 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
 - 4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

- A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.
- B. Thrust restraint may be accomplished by using restrained pipe joints, concrete thrust blocks, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this

Section.

- C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.
- D. Restrained Pipe Joints:
 - 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 05 19, Ductile Iron Process Pipe; lugs and tie rods; or other joint restraint systems approved by ENGINEER.
 - b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Buried Piping Schedule in this Section. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
 - c. Thermoplastic and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of ENGINEER.
 - d. Prestressed Concrete Cylinder Pipe Joints: Restrain utilizing clamp type restrained joint, snap ring-type restrained joint, or by welding. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle thrust forces at maximum design stress of 12,500 psi. Thrust forces in longitudinales must be transmitted directly to steel joint bands using welded connections sufficient to carry stresses involved. No allowance for the concrete to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M9.
 - e. Joints for Concrete Pipe Other than Prestressed Concrete Cylinder Pipe: Restrain joints utilizing clamp type restrained joint or snap ring-type restrained joint.
- E. Concrete Thrust Blocks:
 - 1. Provide concrete thrust blocks on pressure piping at changes in alignment of 15 degrees or more, at tees, plugs and caps, and where shown or indicated in the Contract Documents. Construct thrust blocks of Class B concrete, conforming to 03 30 05, Concrete.
 - 2. Install thrust blocks against undisturbed soil. Place concrete so that pipe and fitting joints are accessible for repair.
 - 3. Concrete thrust block size shall be as shown on the Drawings or as approved by ENGINEER.

3.4 WORK AFFECTING EXISTING PIPING

- A. Location of Existing Underground Facilities:

1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
 2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.
- B. Taking Existing Pipelines and Underground Facilities Out of Service:
1. Conform to Section 01 14 16, Coordination with Owner's Operations.
 2. Do not take pipelines or Underground Facilities out of service unless specifically listed in Section 01 14 16, Coordination with Owner's Operations, or approved by ENGINEER.
 3. Notify ENGINEER in writing prior to taking pipeline or Underground Facilities out of service. Shutdown notification shall be provided in advance of the shutdown in accordance with the General Conditions and Section 01 14 16, Coordination with Owner's Operations.
- C. Work on Existing Pipelines or Underground Facilities:
1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
 2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
 3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
 4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations, Section 01 73 29, Cutting and Patching, and Section 01 73 24, Connections to Existing Facilities.

3.5 FIELD QUALITY CONTROL

- A. General:
1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
 2. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
 3. Conduct all tests in presence of ENGINEER.
 4. Remove or protect pipeline-mounted devices that could be damaged by testing.
 5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
 6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.

7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.
8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of OWNER. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:

1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Buried Piping Schedule in this Section:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires separate test.
 - b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
 - c. Disinfect for bacteriological testing piping that conveys potable water.
4. Test Pressure:
 - a. Use test pressures listed in Buried Piping Schedule in this Section.
 - b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:

1. Preparation for Testing:
 - a. For thermoplastic pipe and fiberglass pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
 - b. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
 - c. For steel pipe, follow procedures described in ANSI/AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
 - d. For other piping follow procedures described in ANSI/AWWA Manual M9, except that minimum wetting period required immediately prior to testing for asbestos cement pipe shall be 24 hours rather than the 48 hours

prescribed for concrete pipe. Wetting period is not required for pipe that is not cement mortar-lined.

- e. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.

2. Test Procedure:

- a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
- b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
- c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
- d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
- e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
- f. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
- g. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.
- h. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:

- a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
- b. Rates based on formula or table in ANSI/AWWA Manual M41:
 - 1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
 - a) Bell and spigot and push-on joints.
 - b) Mechanical joints.
 - c) Bolted sleeve type couplings.
 - d) Grooved and shouldered couplings.
- c. Rates based on make-up allowance in ANSI/AWWA Manual M9:
 - 1) Prestressed concrete cylinder pipe and other types of concrete pipe joined with O-ring rubber gasket sealing members.
- d. Rates based on formula or table in ANSI/AWWA C605:

- 1) Plastic pipe joined with O-ring gasket sealing members.
- e. Rates based on formula or table in ANSI/AWWA C603:
 - 1) Asbestos-cement pipe.
- D. Sewer Testing with Low Pressure Air:
 - 1. Plug and bulkhead ends and lateral connections of pipe segment to be tested.
 - 2. Required test pressure shall be increased by an amount equal to the elevation of groundwater above invert of lowest point of pipe segment being tested.
 - 3. Test in accordance with requirements of authority having jurisdiction.
 - 4. If there are no Laws and Regulations covering the test, use test procedures described in the following standards:
 - a. Thermoplastic and HDPE Pipe: ASTM F1417.
 - b. Concrete Pipe: ASTM C924.
 - c. Clay Pipe: ASTM C828.
- E. Vertical Deflection Test for Thermoplastic, FRP, and HDPE Pipe:
 - 1. Conduct vertical deflection test at least thirty days after backfill has been placed.
 - 2. Manually pull pin-type vertical gauge mounted on sled through pipe. Gauge shall be manufactured by Quality Test Products, or equal. Set gauge so that sled will stop if vertical deflection of pipe exceeds five percent. Excavate and re-install piping that fails deflection test, and retest.
- F. Bacteriological Testing:
 - 1. Bacteriological testing for potable water lines, finished water lines, and other piping in accordance with the Buried Piping Schedule, is specified in Article 3.6 of this Section.

3.6 CLEANING AND DISINFECTION

- A. Cleaning, General: Clean pipe systems as follows:
 - 1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
 - 2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.
 - 3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with five percent sodium hypochlorite solution.
- E. Disinfection:
 - 1. Disinfect all potable and finished water piping.
 - 2. Suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures may be considered for acceptance by ENGINEER.
 - a. Prior to disinfection, clean piping as specified and flush thoroughly.

- b. Conform to procedures described in ANSI/AWWA C651. Use continuous feed method of disinfecting, unless alternative method is acceptable to ENGINEER.
3. Water for initial flushing, testing, and disinfection will be furnished by OWNER. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances, and services required. Cost of water required for re-disinfection will be paid by CONTRACTOR to OWNER at water utility's standard rates.
4. Chlorine shall be provided by CONTRACTOR.
5. Bacteriologic tests will be performed by CONTRACTOR.
6. Chlorine concentration in water entering the piping shall be between 50 and 100 ppm, such that minimum residual concentration of 25 mg/L remains after 24-hour retention period. Disinfect piping and all related components. Repeat as necessary to provide complete disinfection.
7. After required retention period, flush chlorinated water to closed drain line, unless otherwise acceptable to ENGINEER. Properly dispose of chlorinated water in accordance with Laws and Regulations. Do not discharge chlorinated water to storm sewers, ditches, or overland.

3.7 SCHEDULES

- A. Schedules listed below, following the "End of Section" designation, are part of this Specification section.
 1. Table 33 05 05-A, Buried Piping Schedule.

+ + END OF SECTION + +

TABLE 33 05 05-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
Storm	6 – 15	PVC			SDR 35	BS	AIR	
Bypass / Pump Around	16 – 20	DI	CL	AC	350	RMJ	HYD(100)	
Natural Gas	*	*		*	*	*	*	*In Accordance with SCG Requirements

The following abbreviations are used in the Buried Piping Schedule.

A. Service Abbreviations

Service	Abbrev		Service	Abbrev.
Sanitary Sewer	SAN		Wastewater	WW
Storm Sewer	ST		Overflow	OF
Combined Sewer	CS		Centrate	CEN
Sanitary Force Main	SFM		Filtrate	FILT
Raw Water	RW		Scum	SCUM
Potable Water	PW		Primary Sludge	PS
City Water	CW		Return Activated Sludge	RAS
Non-Potable Water	NPW		Waste Activate Sludge	WAS
Plant Effluent Water	PEW		Thickened Sludge	TS
Spray Water	SPW		Mixed Sludge	MS
Backwash Water	BW		Digested Sludge	DS
Hot Water Supply	HWS		Chlorine Solution	CLS
Hot Water Return	HWR		Sodium Hydroxide	NAOH
Influent	INF		Sodium Hypochlorite	NAOCL
Effluent	EFF		Polymer Solution	POLYS
Drain	DR		Alum	AL
Process Air	PA		Hydraulic Fluid	HF
Instrument Air	IA		Fuel Oil	FO
Digester Gas	DIG		Lube Oil	LO
Chlorine Gas	CLG			

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Ductile Iron	DI		Polyvinyl Chloride	PVC
Cast Iron	CI		Chlorinated Polyvinyl Chloride	CPVC
Carbon Steel	CS		Polyethylene	PE
Stainless Steel	SS		High Density Polyethylene	HDPE
Copper	C		Fiberglass Reinforced Plastic	FRP
Corrugated Metal Pipe	CMP		Acrylonitrile Butadiene Styrene	ABS
Reinforced Concrete Pipe	RCP		Vitrified Clay	VC
Prestressed Concrete Cylinder Pipe	PCCP			
Non-Prestressed Concrete Cylinder Pipe	CCP			
Steel Cylinder Pipe	SCP			

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Asphaltic Coated	AC
Glass Lined	GL		Polyethylene Wrapped	PEW
Ceramic Epoxy	CE		Painted	P
Fusion Bonded Epoxy Lined	FBEL		Fusion Bonded Epoxy Coated	FBEC
Plastic Lined	PL		Insulated	I
			Galvanized	Galv

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Bell and Spigot	BS		Butt Weld	BW
Restrained Bell and Spigot	RBS		Lap Weld	LW
Push-on Joint	POJ		Butt Fusion Weld	BFW
Restrained Push-on Joint	RPOJ		Solvent Weld	SW
Mechanical Joint	MJ		Sleeve-type Flexible Coupling	SLFC
Restrained Mech. Joint	RMJ		Split Flexible Coupling	SPFC
Soldered	Sd		Plasticized PVC Coupling	PPVC
Brazed	Bz		Grooved or Shouldered End Coupling	GSEC
Threaded	Thd		Flanged	Flg
Compression Sleeve Coupling	CSC		Compression Flange Adapter	CFA

E. Test Abbreviations

Test	Abbrev		Test	Abbrev.
Hydrostatic Test (test pressure in psig)	HYD ()		Process Air Pipe Test (test pressure in psig)	PA ()
Exfiltration	EX		Chlorine Pipe Test	CL
Low-pressure Air Sewer Test	AIR		Disinfection and Bacteriological Testing	DBT
Vacuum Test	VAC		Examination of Welds	EW
Vertical Deflection	VD		No Test Required	NR
Televised Inspection	TV			

SECTION 33 13 13
SANITARY SEWERAGE

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes gravity-flow, non-pressure sanitary sewerage outside the building up to 5 feet of the building, with the following components:
 - 1. Cleanouts.
 - 2. Precast concrete manholes.

1.2 SUBMITTALS

- A. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
- B. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.2 PVC PIPE AND FITTINGS

- A. Plastic Pipe: ASTM D 3034 SDR-35, Poly Vinyl Chloride (PVC) material; inside nominal diameter as indicated or minimum of 8 inches, bell and rubber gasket joint end.

2.3 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

- D. Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- E. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.4 CLEANOUTS

- A. A.Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 1. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.5 MANHOLES

- A. General: Provide precast reinforced concrete sewer manholes as indicated, complying with ASTM C 478.
- B. Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated.
- C. Base: Precast concrete, with base riser section and separate base slab, or base riser section with integral floor, as indicated.
- D. Steps: Grade 60 steel encased in copolymer polypropylene plastic, integrally cast into manhole sidewalls.
- E. Frame and Cover: Ductile-iron, cover, heavy duty, indented top design, with lettering cast into top reading "SEWER" or as required by local authority.
- F. Pipe Connectors: Resilient, complying with ASTM C 923.

2.6 CAST-IN-PLACE CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4200 psi minimum, with 0.50 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3600 psi minimum, with 0.50 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: Two percent (2%) minimum through manhole.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: Eight percent (8%).
- D. Ballast and Pipe Supports: Portland cement design mix, 3600 psi minimum, with 0.50 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Shielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
- B. Gravity-Flow, Nonpressure Sewer Piping: Use any of the following pipe materials for each size range:
 - 1. NPS 4 and NPS 6: Hub-and-spigot, Extra-Heavy or Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. NPS 4 and NPS 6: NPS 6 ductile-iron, gravity sewer pipe; ductile-iron standard fittings; gaskets; and gasketed joints.
 - 3. NPS 6 and NPS 6: NPS 6 PVC sewer pipe and fittings, gaskets, and gasketed joints.
 - 4. NPS 8 and NPS 10: Ductile-iron, gravity sewer pipe; ductile-iron standard fittings; gaskets; and gasketed joints.
 - 5. NPS 8 and NPS 10: PVC sewer pipe and fittings, gaskets, and gasketed joints.
 - 6. NPS 12 to NPS 16: Ductile-iron, gravity sewer pipe; ductile-iron standard fittings; gaskets; and gasketed joints.
 - 7. NPS 12 and NPS 15: PVC sewer pipe and fittings, gaskets, and gasketed joints.

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of one percent (1%), unless otherwise indicated.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 3. Install piping with 36-inch minimum cover, with top at least 12 inches below level of maximum frost penetration.
 - 4. Install piping below frost line.
 - 5. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Follow piping manufacturer's written instructions for basic piping joint construction.
- B. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
 - 3. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.

4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
5. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 4 inches above finished surface elsewhere, unless otherwise indicated.

3.5 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.6 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's storm drainage system.
- B. Make connections to existing piping and underground manholes.
 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3.7 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred at completion of backfill.
 1. Submit report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.

- b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than ninety-two and one-half percent (92.5%) of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least twenty-four (24) hours advance notice.
 - 4. Submit separate report for each test.
 - 5. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

+ + END OF SECTION + +

SECTION 33 41 00

STORM DRAINAGE

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:
 - 1. Cleanouts.
 - 2. Manholes.
 - 3. Catch basins.
 - 4. Trench drain.
 - 5. Piping.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For precast manholes and catch basins. Include plans, elevations, sections, details, and manhole frames and covers and catch basin frames and grates.
- C. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. PVC Plastic Pipe and appurtenances: ASTM D 1785, Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120; inside nominal diameter as indicated or minimum of 8 inches, bell and solvent welded joints.
- B. PVC Plastic Pipe and appurtenances: ASTM D 3034 SDR-35, Poly Vinyl Chloride (PVC) material; inside nominal diameter as indicated or minimum of 6 inches, bell and rubber gasket joint end.

2.2 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- B. Filter Fabric: Water pervious type, Mirafi 500X, or approved equal.

2.3 CLEANOUTS

- A. Cast-Iron Cleanouts: See Drawings.

2.4 CAST-IN-PLACE CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Ballast and Pipe Supports: Portland cement design mix, 4200 psi minimum, with 0.50 maximum water-cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.5 CATCH BASINS

- A. Provide storm sewer structures per Form 816 Section M.08.02 with type 'C' or type 'CL' catch basin top as indicated or as required by Engineer.
- B. Shaft Construction and Corbel Top Section: Reinforced precast concrete sections, sumps, lipped joints, nominal shaft dimensions for conditions indicated.

2.6 TRENCH DRAINS

- A. Precast concrete trench drains shall be heavy-duty type and shall conform to the following:
 - 1. Dimensions: As shown on Drawings.
 - 2. Concrete: 4,000 psi (28 days).
 - 3. Steel Reinforcement: ASTM-A-615-68, Grade 40. 1" minimum cover.
 - 4. Grates: As shown on Drawings.
 - 5. Design Loading: H-20 loading.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
 - a. Shielded flexible couplings for same or minor difference OD pipes.

- b. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
- B. Gravity-Flow, Nonpressure Sewer Piping: Use any of the following pipe materials for each size range:
 - 1. NPS 4 to NPS 6: See Drawings.
 - 2. NPS 8 to NPS 12: See Drawings.
 - 3. NPS 15 to NPS 60: See Drawings.

3.2 PIPING INSTALLATIONS

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of two percent (2%), unless otherwise indicated.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 3. Install piping with 24-inch minimum cover, at least 12-inches below level of maximum frost penetration.
 - 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 5. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.3 PIPE JOINT CONSTRUCTION

- A. Basic pipe joint construction is specified below. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
 - 3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 - 4. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
 - 5. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
 - 6. Join corrugated steel sewer piping according to ASTM A 798.
 - 7. Join corrugated aluminum sewer piping according to ASTM B 788.
 - 8. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
 - 9. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 10. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent cemented joints.
 - 11. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
 - 12. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
 - 13. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
 - 14. Join fiberglass sewer piping according to ASTM D 3839 for elastomeric-seal joints.
 - 15. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 16. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 17. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 6 inches deep. Set with tops 1 inch above surrounding grade.

- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.5 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.6 TRENCH DRAIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.7 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's storm building drains.
- B. Make connections to existing piping and underground manholes, catch basins, and galleries.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3.8 FIELD QUALITY CONTROL

- A. A. Inspect interior of piping to determine whether line displacement or other damage has occurred.
 - 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than ninety-two and one-half percent (92.5%) of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 3. Reinspect and repeat procedure until results are satisfactory.
- B. Replace leaking piping using new materials, and repeat testing until leakage is repaired.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections.
 - b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
 - c. Work on or affecting existing exposed piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
 - e. Supports, restraints, and other anchors.
 - f. Field quality control, including testing.
 - g. Cleaning and disinfecting.
 - h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Mechanical.

C. Related Sections:

1. Section 09 91 00, Painting.
2. Section 10 14 00, Signage.
3. Section 40 05 07, Pipe Hangers and Supports.
4. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
5. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.
6. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

- A. Standards referenced in this Section are:
1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings
 2. ASME Boiler and Pressure Vessel Code.
 3. ASME B31.3, Process Piping.
 4. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
 5. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
 6. ASTM B32, Specification for Solder Metal.
 7. ASTM D4161, Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
 8. ASTM D4174, Standard Practice for Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
 9. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
 10. AWS D1.1/D1.1M, Structural Welding Code-Steel.
 11. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 12. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
 13. ANSI/AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
 14. ANSI/AWWA C606, Grooved and Shouldered Joints.
 15. ANSI/AWWA C651, Disinfecting Water Mains.
 16. AWWA M9, Concrete Pressure Pipe.
 17. AWWA M11, Steel Pipe - A Guide for Design and Installation.
 18. AWWA M23, PVC Piping - Design and Installation.
 19. AWWA M41, Ductile-Iron Pipe and Fittings.
 20. AWWA M45, Fiberglass Pipe Design.
 21. AWWA M55, PE Pipe - Design and Installation.
 22. SAE J1227, Method for Assessing the Cleanliness Level of New Hydraulic Fluid.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including:
 - a. The Town of Trumbull, Connecticut.
- B. The Work shall conform to seismic requirements in accordance with Section 40 05 96, Vibration, Seismic and Wind Controls.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Detailed drawings in plan and, as applicable, section.
 - b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.
 - 2. Testing Plans, Procedures, and Testing Limitations
 - a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
 - 2. Source Quality Control Submittals:
 - a. Submit copies of testing report for each test.
 - 3. Site Quality Control Reports:
 - a. Submit copies of testing report for each test.
- C. Closeout Submittals: Submit the following:
 - 1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
 - b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
 - c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
 - d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work.
 - 2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
 - 3. Conform to requirements of Section 01 65 00, Product Delivery Requirements.
- B. Storage:

1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
 2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
 3. Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements.
- C. Handling:
1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
 2. Avoid unnecessary handling of pipe.
 3. Keep pipe interiors free of dirt and foreign matter.
 4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
 5. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Integration.
- B. Markings and Identification:
1. Pipe Markings:
 - a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
 2. Pipe Identification Markers and Arrows: Refer to Section 10 14 00, Signage.
- C. Appurtenances: Provide products that comply with:
1. Section 40 05 07, Pipe Hangers and Supports.
 2. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
 3. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.
 - 2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
 - 3. Provide pipe manufacturer's installation specialist at Site as specified on this Section.
- B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
 - 1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
 - 2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
 - 3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
 - 4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.
- C. Piping Installation:
 - 1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
 - 2. Install straight runs true to line and elevation.
 - 3. Install vertical pipe truly plumb in all directions.
 - 4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
 - 5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
 - 6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.
 - 7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.

8. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.

D. Jointing Pipe:

1. General:
 - a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
 - b. Cut piping accurately and squarely and install without forcing or springing.
 - c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
 - d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
2. Ductile Iron Flanged Joints:
 - a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
 - b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
 - c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
 - d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
 - e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
 - f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09 91 00, Painting, for material of pipe and fittings being joined.
3. Steel Pipe Threaded Joints:
 - a. For threaded joints, use standard, right hand tapered full depth threads on steel piping and apply a manufacturer's recommended joint compound to male threads only, before installation.
 - b. Remove cuttings and foreign matter from inside of pipe.
 - c. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
4. Mechanical Coupling Joints:
 - a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end

couplings, plasticized PVC couplings, and other mechanical couplings used.

- b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with a wire brush to remove foreign matter.
- c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
- d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove the clamps from the coupling. Slide the coupling over the plain ends of the pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with a torque wrench to torque recommended by manufacturer.

E. Installing Valves and Accessories:

1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
3. Position swing check valves and butterfly valves so that they do not conflict with upstream and downstream elements of the piping system.

F. Unions:

1. Install dielectric unions as specified in Section 40 05 06, Couplings, Adapters, and Specials for Process Piping, where dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

G. Transitions from One Type of Pipe to Another:

1. Provide all necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

H. Closures:

1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.

3.2 THRUST RESTRAINT

- A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.
- B. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.
- C. Restrained Pipe Joints:
 - 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - a. Prestressed Concrete Cylinder Pipe Joints: Restrain utilizing clamp type restrained joint, snap ring-type restrained joint, or by welding. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle the thrust forces at a maximum design stress of 12,500 psi. Thrust forces in the longitudinals must be transmitted directly to steel joint bands using welded connections sufficient to carry stresses involved. No allowance for concrete to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M-9.
 - c. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with a proprietary restrained joint system as specified in Section 40 05 19. Ductile iron pipe, lugs, and tie rods, or other joint restraint systems approved by ENGINEER. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
 - d. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Exposed Piping Schedule. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
 - e. Thermoplastic, FRP and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across the joint or other suitable joint restraint system, subject to approval of ENGINEER.

3.3 WORK AFFECTING EXISTING PIPING

- A. Location of Existing Piping:
 - 1. Locations of existing piping shown on Drawings is approximate.
 - 2. Determine the true location of existing piping to which connections are to be made, crossed, and that could be disturbed, and determine location of other facilities that could be affected by the Work.
- B. Taking Existing Pipelines Out of Service:
 - 1. Conform to Section 01 14 16, Coordination with Owner's Operations.
- C. Work on Existing Pipelines:

1. Cut or tap pipes as shown or required with machines and tools specifically designed for cutting or tapping pipelines.
2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations and Section 01 73 24, Connections to Existing Facilities.

3.4 PAINTING

- A. Field painting shall conform to Section 09 91 00, Painting.

3.5 FIELD QUALITY CONTROL

A. Testing, General:

1. Test all piping, except as exempted in the Exposed Piping Schedule.
2. Notification:
 - a. Notify ENGINEER at least 48 hours prior to testing.
 - b. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
3. Conduct all tests in presence of ENGINEER.
4. Remove or protect pipeline-mounted devices that could be damaged by testing.
5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.
8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or OWNER. Repair of existing piping will be paid as extra work unless otherwise specified.

B. Test Schedule:

1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.

2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
 3. For piping not listed in Exposed Piping Schedule:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires a separate test.
 - b. Disinfect for bacteriological testing piping that conveys potable water.
 4. Test Pressure:
 - a. Use test pressures listed in Exposed Piping Schedule.
 - b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.
- C. Hydrostatic Testing:
1. Preparation for Testing:
 - a. Follow piping follow procedures described in AWWA Manual M9.
 - b. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
 2. Test Procedure:
 - a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
 - b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
 - c. Examine joints and valves, and make repairs to eliminate visible leakage.
 - d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 - e. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
 - f. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. The test pressure shall then remain steady for one hour, indicating no leakage.
 - g. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen minute intervals for duration of test.
 3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:

- a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

3.6 CLEANING AND DISINFECTION

- A. Cleaning, General: Clean pipe systems as follows:
 - 1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in a manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
 - 2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.

3.7 EXPOSED PIPING SCHEDULE

- A. The schedules listed below, following the “End of Section” designation, are a part of this Specification section.
 - 1. Table 40 05 05-A, Exposed Piping Schedule.

TABLE
40 05 05-A, EXPOSED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
Pump Suction / Discharge	12 - 20	DI	CL	P	350	Flg	HYD (150)	
Air Release Valve Piping	1 – 2	316SS			Sch 40S	Thd	HYD (150)	

A. Service Abbreviations

Service	Abbrev.		Service	Abbrev.
Sanitary Force Main	SFM		Overflow	OF
Raw Water	RW		Centrate	CEN
Potable Water	PW		Filtrate	FILT
City Water	CW		Scum	SCUM
Non-Potable Water	NPW		Primary Sludge	PS
Plant Effluent Water	PEW		Return Activated Sludge	RAS
Spray Water	SPW		Waste Activate Sludge	WAS
Backwash Water	BW		Thickened Sludge	TS
Hot Water Supply	HWS		Mixed Sludge	MS
Hot Water Return	HWR		Digested Sludge	DS
Influent	INF		Chlorine Solution	CLS
Effluent	EFF		Sodium Hydroxide (Caustic)	NAOH
Drain	DR		Sodium Hypochlorite	NAOCL
Process Air	PA		Polymer Solution	POLYS
Instrument Air	IA		Alum	AL
Digester Gas	DIG		Hydraulic Fluid	HF
Chlorine Gas	CLG		Fuel Oil	FO
Wastewater	WW		Lube Oil	LO

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Ductile Iron	DI		Polyvinyl Chloride	PVC
Cast Iron	CI		Chlorinated Polyvinyl Chloride	CPVC
Carbon Steel	CS		Polyethylene	PE
Stainless Steel	SS		High Density Polyethylene	HDPE
Copper	C		Fiberglass Reinforced Plastic	FRP
Prestressed Concrete Cylinder Pipe	PCCP			
Non-Prestressed Concrete Cylinder Pipe	CCP			
Steel Cylinder Pipe	SCP			

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Painted	P
Glass Lined	GL		Insulated	I
Ceramic Epoxy	CE		Galvanized	Galv
Fusion Bonded Epoxy Lined	FBEL			
Plastic Lined	PL			

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Bell and Spigot	BS		Flanged	Flg
Restrained Bell and Spigot	RBS		Butt Weld	BW
Push-on Joint	POJ		Lap Weld	LW
Restrained Push-on Joint	RPOJ		Butt Fusion Weld	BFW
Mechanical Joint	MJ		Solvent Weld	SW
Restrained Mech. Joint	RMJ		Sleeve-type Flexible Coupling	SLFC
Soldered	Sd		Split Flexible Coupling	SPFC
Brazed	Bz		Plasticized PVC Coupling	PPVC
Threaded	Thd		Grooved or Shouldered End Coupling	GSEC
			Flanged Adapter	FA

E. Test Abbreviations

Test	Abbrev		Test	Abbrev.
Hydrostatic Test (test pressure in psig)	HYD ()		Disinfection and Bacteriological Testing	DBT
Process Air Pipe Test (test pressure in psig)	PA ()		Examination of Welds	EW
Chlorine Pipe Test	CL		Exfiltration Test	EX
			No Test Required	NR

++ NO TEXT ON THIS PAGE ++

SECTION 40 05 06

COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all couplings, adapters, and specials for process piping.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before couplings, adapters, and specials for process piping Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 33 05 05, Buried Piping Installation
 - 3. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
 - 2. ASME B31, Standards of Pressure Piping.
 - 3. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-dipped, Zinc-Coated, Welded and Seamless.
 - 4. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
 - 5. AWWA C606, Grooved and Shouldered Joints.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer shall have at least five years experience producing substantial similar products to those specified and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.
- B. Component Supply and Compatibility:
 - 1. Obtain each type of coupling, adapter, and special for process piping product included in this Section, regardless of component manufacturer, from a single couplings, adapters, and specials manufacturer.

2. Supplier shall prepare, or review, and approve all submittals for components furnished under this Section.
3. Components shall be suitable for specified service conditions and be integrated into overall assembly by the Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
2. Product Data:
 - a. Submit product data on each type of coupling, expansion joint, and other piping specialties and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
2. Manufacturer's Instructions:
 - a. Provide instructions for handling, storing, installing, and adjusting of products.
3. Source Quality Control:
 - a. When requested by ENGINEER, submit results of source quality control tests.
4. Qualifications Statements:
 - a. Submit qualifications of manufacturer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 COUPLINGS

A. Sleeve-type, Flexible Couplings:

1. Pressure and Service: Same as connected piping.
2. Products and Manufacturers: Provide products of one of the following:

- a. Style 38, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
 - b. Style 441, by Smith Blair, Inc.
 - c. Or equal.
 3. Material: Ductile Iron.
 4. Gaskets: Suitable for specified service, as recommended by manufacturer.
 5. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
 6. Harnessing:
 - a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - b. Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
 - c. On plain-end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.
 - d. Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.
 7. Remove pipe stop(s) if used, unless otherwise shown or specified.
- B. Flanged Coupling Adapters:
1. Description: One end of adapter shall be flanged and opposite end shall have sleeve-type flexible coupling.
 2. Products and Manufacturers: Provide one of the following:
 - a. Style 128, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
 - b. Style 913, by Smith Blair, Inc.
 - c. Or equal.
 3. Pressure and Service: Same as connected piping.
 4. Material: Ductile iron.
 5. Gasket: Recommended by the manufacturer.
 6. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and nitrided stainless nuts.
 7. Harnessing:
 - a. Harness adapters to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

- b. For flanged adapters 12-inch diameter and smaller, provide 1/2-inch diameter (minimum) Type 316 stainless steel anchor studs installed in pressure-tight anchor boss. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by flanged adapter manufacturer. Provide the following minimum anchor studs unless otherwise approved by ENGINEER.
 - 1) Six-inch Diameter and Smaller: Two
 - 2) Eight-inch Diameter and Smaller: Four
 - 3) Ten-inch Diameter and Smaller: Six
 - 4) Twelve-inch Diameter and Smaller: Eight
 - c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with minimum of four corrosion-resistant alloy steel bolts. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Harness assembly shall be as designed and recommended by flanged adapter manufacturer. Dimensions, sizes, spacing and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.
- C. Split-type Grooved or Shouldered End Couplings:
 - 1. Pressure and Service: Same as connected piping. Use shouldered end where required by pressure rating.
 - 2. Products and Manufacturers:
 - a. For coupling of cast-iron or ductile iron pipe, provide products of one of the following:
 - 1) Style 31, as manufactured by Victaulic Company.
 - 2) Series 500, as manufactured by Tyler Pipe, Gustin Bacon Division.
 - 3) Gruvlok Figure 705, as manufactured by Grinnell Mechanical Products, division of Tyco.
 - 4) Or equal.
 - 3. Couplings shall conform to applicable requirements of AWWA C606.
 - 4. Housing Material:
 - a. For coupling of cast-iron pipe, ductile iron pipe, steel pipe, and thermoplastic pipe: Malleable iron or ductile iron.
 - 5. Gaskets: Recommended by the manufacturer.
 - 6. Bolts and Nuts: Heat-treated carbon steel track bolts, plated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.

2.2 PAINTING

- A. Shop Painting:

1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09 91 00, Painting, unless otherwise specified in this Section
2. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until products are placed into operation.

B. Field painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

3.2 INSTALLATION

- A. Installation:
1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
 2. For buried installations, refer to Section 33 05 05, Buried Piping Installation.
 3. For exposed installations, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 40 05 07

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to design, furnish, and install all hangers, supports and appurtenances necessary to complete the Work.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports Work.
- C. Related Sections:
 - 1. Section 05 50 13, Miscellaneous Metal Fabrications.
 - 2. Section 09 91 00, Painting.
 - 3. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 575, Specification for Steel Bars Carbon, Merchant Quality, M-Grades.
 - b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
 - 2. Federal Specification, (FS).
 - a. FS A-A-1192, Hangers, Pipe.
 - 3. Manufacturers Standardization Society of the Valve and Fittings Industry, (MSS).
 - a. MSS SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
 - b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
 - 4. Underwriters' Laboratories, Inc., (UL).
 - a. UL 203, Pipe Hanger Equipment for Fire Protection Service.

1.3 QUALITY ASSURANCE

- A. Each type of pipe hanger or support shall be the product of one manufacturer.
- B. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pipe hangers and supports manufacturer.
2. The pipe hangers and supports equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe hangers and supports equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Detailed drawings showing all hangers and supports for each piping system specified. Shop Drawings shall show location, installation, material, loads or forces, and deflection of all hangers and supports.
 - b. Each pipe system shall be analyzed for all loads and forces on the hangers and supports. Provide calculations of reaction forces to the structure to which they are fastened. Calculations shall be signed and sealed by a registered Professional Engineer in the State of Connecticut. Provide confirmation that hanger systems comply with support requirements and codes.
 - c. Submit and coordinate these with Shop Drawings required for all piping systems.
2. Product Data:
 - a. Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP 58, MSS SP 69 and Federal Specification A-A-1192.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store materials in covered storage off the ground and prevent condensation.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if

any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Hangers and supports shall meet with the following requirements:
1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
 2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
 3. Install hangers or supports at all locations where pipe changes direction.
 4. All hangers and supports shall be capable of adjustment after placement of piping.
 5. Different types of hangers or supports shall be kept to a minimum.
 6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
 7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
 8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
 9. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

Pipe Size (inches)	Maximum Pipe Span ¹ (feet)			
	Steel	Copper	Plastic ²	Cast/Ductile Iron ⁴
3/8 to 3/4	5	6	Cont. ³	-
1	6	6	5	-
1-1/4	6	6	5	-
1-1/2	6	6	5	-
2	10	10	5	-
2-1/2	10	10	5	-
3	10	10	5	-
4	12	12	5	12 feet for pressure pipe
6	12	12	5	
8	12	12	5	
10	12	-	5	
12	12	-	10	
14	12	-	-	
16	12	-	-	10 feet for
18	12	-	-	
20	12	-	-	

24	12	-	-	soil pipe

¹Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

²Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

³Continuous means pipe shall be in unistrut or similar channel.

⁴Pipe hanger and support selection shall be as shown and in this Section.

10. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130°F shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended there from.
13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports.
14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:

1. $\Delta L = L \times \Delta T \times \alpha$
 - a. Where ΔL = pipe length change (inches).
 - b. L = pipe length between anchors (inches).
 - c. ΔT = 100 (F).
 - d. α = coefficient of thermal expansion (inches/inches/F).
2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
3. Expansion compensation shall be achieved via expansion joints specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

2.2 HANGERS AND SUPPORTS

A. Hangers and supports shall be designed and provided by the Contractor, and shall be in accordance with MSS SP 58.

B. Manufacturers: Provide one of the following:

1. Anvil International, Inc.
2. Elcen.
3. B-Line.
4. Unistrut Corporation.
5. Or equal.

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:

1. Concrete inserts shall be MSS SP 58 malleable Type 18.
2. Manufacturers: Provide products of one of the following:
 - a. Unistrut Corporation, Wayne, Michigan.
 - b. Elcan Metal Products, Company, Franklin Park, Illinois.
 - c. B-Line.
 - d. Anvil International, Inc.
 - e. Or equal.

C. Brackets:

1. Brackets for wall mounting shall conform to MSS SP 58 Type 32.

D. Fabricated Pipe Rack:

1. Pipes shall be supported and anchored to the fabricated pipe rack as shown. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP 69.

2.4 PAINTING

A. Clean and prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09 91 00, Painting.

B. Field painting shall conform to the requirements of Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

- C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
1. Temperature differential specified in this Section.
 2. Support piping independently so that equipment is not stressed by piping weight or expansion.
 3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. Instrumentation tubing shall be supported in steel or aluminum troughs with covers. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
 4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
 5. Maximum spacing for horizontal piping:
 - a. Steel 1-Inch and Smaller: Seven feet.
 - b. Steel 1-1/2-Inch and Larger: Ten feet.
 - c. Brass or Copper 3-Inch and Smaller: Seven feet.
 - d. Brass or Copper 4-Inch and Larger: Ten feet.
 - e. Additional supports at:
 - 1) Change in direction.
 - 2) Branch piping and runouts over five feet.
 - 3) Concentrated loads due to valves, strainers or other similar items.
 - f. Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values.
 6. Hanger types for horizontal piping, except as noted and shown:
 - a. Forged steel adjustable clevis type, rod support for all services.
 - b. Slide Bases:
 - 1) Pipe stand, brackets, trapeze or other equivalent structural support.
 - 2) For piping 2-inches or larger.
 - c. For pipe and covering provide:
 - 1) Saddles for rollers or slide bases.
 - 2) Protective shields or saddles for all other types of supports.
 - d. Threaded Steel Rods:
 - 1) Two inch vertical adjustment with two nuts each end for positioning and locking.
 - 2) Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

- 3) For Double Rod Hangers: One size smaller than above.

- 4) Connection to Structure for Piping to 2-Inches: Concrete inserts, or expansion shields in shear into sides of beams.
- 5) Connection to Structure for Piping 2-1/2-Inch or Larger: Concrete inserts, beam clamps or suitable bridging.

7. Vertical Piping:

- a. Base Support: Base elbow or welded equivalent.
 - 1) Bearing plate on structural support.
- b. Guides not to exceed:
 - 1) 25 feet for piping to 2-inches.
 - 2) 36 feet for piping 2-1/2-inches or larger.
- c. Top Support:
 - 1) Special hanger or saddle in horizontal connection.
 - 2) Provisions for expansion.
- d. Intermediate Supports: Steel pipe clamp at floor.
 - 1) Bolted and welded to pipe.
 - 2) Extension ends bearing on structural steel or bearing plates.
- e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.

8. Insulated Piping:

- a. Horizontal Pipe Shields at Supports:
 - 1) Minimum 120 degree arc.
 - 2) Length equal to diameter of insulation 12-inch minimum.
 - 3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.
- b. Vertical Pipe Shields at Guides:
 - 1) Full 360 degree arc, securely banded.
 - 2) Length equal to diameter of insulation, 12-inch minimum.
 - 3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.

- D. Install items to be embedded before concrete placement.
- E. Fasten embedded items securely to prevent movement during concrete placement.
- F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations.
- G. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.
- H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 40 05 08

WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces, and escutcheons to complete the Work.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate with the installation of floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons that must be installed with or within formwork, walls, partitions, ceilings and panels.
- C. Related Sections:
 - 1. Section 03 30 05, Concrete.
 - 2. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - a. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
 - b. ANSI B16.4, Gray-Iron Threaded Fittings.
 - 2. American Water Works Association, (AWWA).
 - a. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - b. AWWA C110 (ANSI A21.10), Ductile-Iron and Gray-Iron Fittings, for Water.
 - c. AWWA C111 (ANSI A21.11), Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - d. AWWA C115 (ANSI A21.15), Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - e. AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - f. AWWA C200, Steel Water Pipe 6-Inches and Larger.

1.3 QUALITY ASSURANCE

- A. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single wall pipes, floor pipes and pipe sleeves manufacturer.
2. The wall pipes, floor pipes and pipe sleeves manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the wall pipes, floor pipes and pipe sleeves manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Detailed drawings and data on all wall and floor pipe, and pipe sleeves. Submit and coordinate these with Shop Drawings required for all piping systems.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Wall and Floor Pipes:
 1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by ENGINEER.
 2. End Connections: As shown.
 3. Thickness: Same as specified for the piping connected to wall or floor pipe.
 4. Collars: Provide collars at mid-point of wall for anchorage and watertightness.
 5. Pipes ends shall be flush with wall face, unless otherwise shown.
 6. Drill and tap flanged ends and mechanical joint bells for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of Type 316 stainless steel.
- B. Pipe Sleeves:
 1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown.
 2. Copper Pipe: Use Type K hard drawn copper pipe, unless otherwise shown.
- C. Cast Wall Sleeves:
 1. Material: Ductile iron furnished with integral wall collar.

2. Dimensions: As required for mechanical joint pipe to pass through sleeve. Length as required.
- D. Link Seals: Provide link type mechanical seals suitable for 20 psi working pressure, corrosive service and accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
1. Products and Manufacturers: Provide one of the following:
 - a. Link-Seal, as manufactured by Thunderline Corporation.
 - b. Or equal.
- E. Wall and Ceiling Plates:
1. Bare pipes passing through walls and ceilings in finished rooms: Provide escutcheon plates of cast brass or cast-iron nickel plated, clevis or split ring and hinged with set screws.
 2. Provide plated escutcheon plates of 18-gauge steel for insulated pipes passing through walls and ceilings in finished rooms.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings.
- B. Pipe Sleeves:
1. Use sleeves wherever pipes pass through walls, partitions, floors, and roofs, unless otherwise shown.
 2. Extend all sleeves through floor slabs a minimum of 2-inches above finished floor.
 3. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
 4. All sleeves through walls shall be flush with wall face.
 5. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
 6. Use link type seals to seal sleeve against hydrostatic pressure. Size sleeves to provide annular space required to suit the link type mechanical seals that are used.
 7. Do not install sleeves and pipes through structural members, unless specifically shown and approved by ENGINEER.
 8. Size sleeves to provide annular space as follows:

<u>Pipe Size</u>	<u>Sleeve ID Minus Pipe Or Insulation OD</u>
Less than 2-inches	1/2-inches to 3/4-inches
2-inches to 4-inches	3/4 inches to 1-1/4-inches.

6-inches to 12-inches	1-1/4 inches to 2-inches
Over 12-inches	2-inches to 3-inches

- C. Install wall and ceiling plates in accordance with the manufacturer's recommendations and approved Shop Drawings.

++ END OF SECTION ++

SECTION 40 05 19

DUCTILE IRON PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
2. Extent of piping is shown on the Drawings. Piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.

C. Related Sections:

1. Section 31 20 00, Earth Moving.
2. Section 09 91 00, Painting.
3. Section 40 05 05, Exposed Piping Installation.
4. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
6. ASTM A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
8. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
9. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
10. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
11. ASTM D792, Test Methods for Density and Specific Gravity (Relative

- Density) of Plastics by Displacement.
12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
 13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
 14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
 15. ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings.
 16. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
 17. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
 18. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
 19. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
 20. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
 21. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
 22. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
 23. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
 24. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
 25. European Standard (EN), EN 598: Ductile Iron Pipe, Fittings, Accessories and Their Joints for Sewerage Applications.
 26. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
 27. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 28. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
 29. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 30. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
 31. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
 - b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines exposed to the specified service conditions, and shall be able to show

- evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
- c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:

1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

C. Regulatory Requirements:

1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation:

1. Shop Drawings:
 - a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.
2. Product Data:
 - a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the submittals.
3. Samples:
 - a. Submit Sample of pipe and fitting with each type of lining, for use at the

Site to verify continuity, surface gloss, and color, as applicable, via visual inspection.

4. Test Procedures: For linings and coatings in pipe and fittings.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
2. Source Quality Control Submittals:
 - a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
 - b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:

1. Piping systems shall be suitable for their intended use.
2. Joints shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.

B. Ductile Iron Pipe, Joints, and Fittings:

1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
 - a. Pressure Rating: As specified in piping schedule in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 54-inch diameter pipe and Pressure Class 350 for 60-inch and 64-inch diameter pipe.
2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
 - a. Pressure Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.
 - b. Special Thickness Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.
3. Pipe Joints:

- a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 40 05 05, Exposed Piping Installation.
 - 1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.
 - 2) Bolts: Comply with ANSI B18.2.1.
 - a) Exposed: ASTM A307, Grade B.
 - b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
 - 3) Nuts: Comply with ANSI B18.2.2.
 - a) Exposed: ASTM A563, Grade A, Heavy hex.
 - b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.
- b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 1) Glands: Ductile iron.
 - 2) Gaskets: Plain tip.
 - 3) Bolts and Nuts: High strength, low alloy steel.
 - 4) Manufacturers: Provide products of one of the following:
 - a) Clow Water Systems Company
 - b) Atlantic States Cast Iron Pipe Company
 - c) Canada Pipe Company, Ltd.
 - d) McWane Cast Iron Pipe Company
 - e) Pacific States Cast Iron Pipe Company
 - f) Griffin Pipe Products Co.
 - g) American Cast Iron Pipe Co.
 - h) U.S. Pipe and Foundry Co.
 - i) Or equal.
- c. Push-On Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure class or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 1) Gaskets: Vulcanized SBR, unless otherwise specified.
 - 2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.
 - 3) Products and Manufacturers: Provide one of the following:
 - a) Tyton or Fastite Joint by Clow Water Systems, Atlantic States Cast Iron Pipe Company, Canada Pipe Company, Ltd., McWane

- Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, and Griffin Pipe Products Company.
 - b) Fastite Joint by American Cast Iron Pipe Company.
 - c) Tyton Joint by U.S. Pipe and Foundry Company.
 - d) Or equal.
 - d. Grooved End Joints: Comply with ANSI/AWWA C606.
 - 1) Gaskets: Flush seal type designed for ductile iron that complies with or exceeds requirements of ASTM D2000
 - 2) Bolts and nuts: As specified for flanged joints.
 - 3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
 - 4) Products and Manufacturers: Provide one of the following:
 - a) Victaulic, Style 31.
 - b) Or equal.
 - e. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of ENGINEER.
 - 1) Products and Manufacturers: Provide restrained joints for mechanical joint piping by one of the following:
 - a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
 - b) MJ Coupled Joint, by American Cast Iron Pipe Co.
 - c) MJ Field Lok, by U.S. Pipe and Foundry Co.
 - d) Or equal.
 - 2) Products and Manufacturers: Provide restrained joints for push-on joint piping by one of the following:
 - a) Super-Lock Joint Pipe, by Clow Water Systems, a division of McWane, Inc.
 - b) Lok-Ring Joint, or Flex-Ring Joint, by American Cast-Iron Pipe Company.
 - c) TR Flex Joint, by U.S. Pipe and Foundry Company.
 - d) Snap-Lok, by Griffin Pipe Products Company.
 - e) Or equal.
- 3. Flanged and Push-On Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.
- 5. Mechanical Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - b. Glands: Ductile iron.
 - c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.

C. Lining, General:

1. Typical Service Conditions:

Property	Ductile Iron Pipe
Fluid(s) Conveyed Through Pipe	Sewage
pH range	6 - 9
Temperature Range (degrees F)	70 - 90
Maximum Fluid Velocity (fps)	14
Lining Type	Double Cement Mortar Lining

2. Surface Preparation:

- a. Initial Surface Inspection: Surface to be lined shall be inspected by pipe and fitting manufacturer and applicator, if applicator is other than pipe and fitting manufacturer. Inspecting parties shall inspect surface to be coated and mutually determine recommended surface preparation method.
- b. Surface Preparation: Prepare surface in accordance with recommended method.
- c. Finished Surface Inspection: Lining applicator shall inspect finished surface prior to application to determine acceptability. If surface is unacceptable, repeat surface preparation as necessary.

D. Cement-mortar Lining:

1. Where specified in piping schedules included with Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, pipe and fittings shall be lined with bituminous seal coated cement-mortar lining in accordance with ANSI/AWWA C104.

H. Couplings:

1. Refer to Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.

I. Specials:

1. Transition Pieces:

- a. Provide suitable transition pieces (adapters) for connecting to existing piping.
- b. Unless otherwise shown or indicated, expose existing piping to determine material, dimensions, and other data required for transition pieces.

2. Taps:

- a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
- b. Provide corporation stops where shown or required.
- c. Where pipe wall thickness or tap diameter will not allow engagement of 3 full threads, provide tapping saddle with outlet joints conforming to

- requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 54-inch diameter pipe.
- d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.
3. Tangential Outlets:
- a. Provide tangential outlet fittings where shown or indicated.
 - b. Weld-on fittings are acceptable.
 - c. Flanged and grooved end joints are not allowed.

2.2 MARKING FOR IDENTIFICATION

- A. In addition to identification markings specified in Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
- 1. Name or trademark of manufacturer.
 - 2. Weight, class or nominal thickness, and casting period.
 - 3. Country where cast.
 - 4. Year the pipe was produced.
 - 5. Letters "DI" or "Ductile" shall be cast or metal stamped
- B. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
- 1. Flange manufacturer's mark, size, and letters "DI" cast or stamped on the flanges.
 - 2. Fabricator's mark if other than flange manufacturer.
 - 3. Length and weight.
- C. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify fittings with:
- 1. Manufacturer's identification.
 - 2. Pressure rating.
 - 3. Nominal diameters of openings.
 - 4. Country where cast.
 - 5. Number of degrees or fraction of the circle on bends.
 - 6. Letters "DI" or "Ductile" cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

- A. General Coating Requirements:
- 1. Coating types are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Exposed Pipe and Fittings:

1. Surface Preparation:

- a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
- b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
- c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.

2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09 91 00, Painting.

3. Field painting shall comply with Section 09 91 00, Painting.

C. Buried Pipe and Fittings:

1. Asphaltic Coating: Where specified in piping schedule in Section 33 05 05, Buried Piping Installation, coat pipe and fittings with an asphaltic coating approximately one-mil thick, in accordance with ANSI/AWWA C151, ANSI/AWWA C115, ANSI/AWWA C110, and ANSI/AWWA C153, as applicable.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

- A. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 40 05 23

STAINLESS STEEL PROCESS PIPE FOR LIQUID SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install stainless steel pipe and fittings for liquid service.
2. Extent of piping is shown and shall be in accordance with piping schedules in Section 40 05 05, Exposed Piping Installation.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before stainless steel piping Work.

C. Related Sections:

1. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section include:

1. ANSI B2.1, Pipe Threads.
2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.11 Forged Fittings, Socket Welding and Threaded.
4. ANSI B36.19, Stainless Steel Pipe (ASME B36.19M).
5. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
6. ASTM A276, Specification for Stainless Steel Bars and Shapes.
7. ASTM A312/A 312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
8. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
9. ASTM A403/A403M, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
10. ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
11. ASTM A774/A774M, Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

12. ASTM A778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
13. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
14. AWS D1.6/D1.6M, Structural Welding Code – Stainless Steel.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 1. Manufacturer's Qualifications: Manufacturer shall have a minimum of five years experience producing stainless steel pipe and fittings for liquid service substantively similar to the materials specified, and shall be able to provide documentation of satisfactory service in at least five completed installations.
 2. Welders shall be qualified in accordance with AWS D1.6.
- B. Component Supply and Compatibility:
 1. Obtain all materials included in this Section, regardless of component Supplier, from a single stainless steel pipe manufacturer.
 2. Stainless steel pipe manufacturer shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
 3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by stainless steel pipe Supplier.
- C. Regulatory Requirements: Comply with applicable provisions of the following.
 1. ASME Boiler and Pressure Vessel Code.
 2. National Fire Protection Association

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Piping layout Shop Drawings in accordance with Section 40 05 05, Exposed Piping Installation.
 2. Product Data:
 - a. Product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.
- B. Informational Submittals: Submit the following:
 1. Certificates:
 - a. Certificate of compliance standards referenced in this Section.
 2. Qualifications Statements:
 - a. Manufacturer's qualifications when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
1. Alaskan Copper & Brass Company.
 2. Felker Brothers Corporation.
 3. Douglas Brothers Division, Robert Mitchell Co., Inc.
 4. Or equal.

2.2 MATERIALS

- A. Fabricated Stainless Steel Pipe:
1. Pipe:
 - a. Type: Pipe and fittings less than three-inch diameter shall be seamless. Spiral welded pipe is not acceptable.
 - b. Material: ASTM A240/A240M, Type 316L stainless steel.
 - c. Diameter: Pipe diameters as shown and specified shall mean nominal outside diameter of pipe, except for pipes specified with schedule numbers for wall thickness. Pipes specified with schedule numbers for wall thickness shall conform to ANSI B36.19.
 - d. Wall Design Criteria:
 - 1) Provide a piping that meets fabrication, installation, and service conditions as shown and specified.
 - 2) Based on internal design pressure indicated for test pressure in Section 40 05 05, Exposed Piping Installation.
 - 3) Minimum Wall Thickness:
 - a) Stainless steel piping less than six-inch diameter shall be Schedule 40S. Provide stainless steel pipe less than three-inch diameter with threaded connections conforming to ANSI B2.1.
 - e. Fabrication of stainless steel pipe shall be in accordance with ASTM A312 and ASTM A778, where applicable.
 - 1) Pipe Ends: Perpendicular to longitudinal axis.
 - 2) Roundness: Tolerance of 1/16-inch.
 - 3) Straightness: Tolerance of 1/8-inch in ten feet.
 - 4) Edges: Joint-edges shall be true so as to not leave shoulder on inside of pipe.
 - f. Welding:
 - 1) Longitudinal Welds: Tungsten Inert Gas or Metal Inert Gas.
 - 2) Circumferential Welds: Heliarc or metallic air process.
 - 3) Grinding: Interior welds shall be ground smooth to provide internal bead of 1/16-inch or less.
 - g. Factory Finish:

- 1) Pipe and fittings shall be pickled after manufacture by immersing in acid bath until weld discoloration and iron pickup is removed.
 - 2) Passivate piping welds after fabrication.
 - 3) Thoroughly wash pipe and fittings with clear water after pickling.
2. Joints:
- a. General:
 - 1) Comply with Section 40 05 05, Exposed Piping Installation.
 - 2) Provide flanged joints at connections to valves, equipment, instruments, and at such joints where pipe dismantling may be required to facilitate equipment removal and maintenance.
 - 3) Provide flanged joints for field assembly of exposed and submerged piping.
 - 4) Joints shall be shop welded, unless otherwise shown or specified.
 - 5) Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-welded joints or flanges.
 - b. Flanged Joints:
 - 1) Two-part flange:
 - a) Slip-on rolled angle face rings of 1/8-inch stainless steel for pipe less than 16-inch diameter. Angle face ring thickness shall be equal to or greater than wall of pipe or fitting to which angle face ring is welded, and continuously weld angle face ring to pipe or fitting on both sides. Angle leg shall not interfere with flange bolt holes.
 - b) Backing Flange: Hot-dipped galvanized ductile-iron drilled to ANSI B16.1 Class 125 standards. For submerged joints, backing flanges shall be stainless steel plate flanges. Minimum flange thickness shall be 11/16-inch.
 - 2) Gaskets:
 - a) Comply with stainless steel pipe manufacturer's recommendations for service conditions shown and as specified.
 - 3) Bolts and Nuts:
 - a) Provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 314 and with nitrided stainless nuts.
3. Fittings:
- a. Type: Welded or flanged as shown, all stainless steel.
 - b. Construction:
 - 1) Stainless steel fittings, 2.5-inch diameter and smaller, shall be ASTM A403/A403M, of same material and pressure rating as associate pipe, threaded, long-radius with dimensions conforming to ANSI B16.11.
 - 2) For general corrosive service at low and moderate temperatures, comply with ASTM A774/A774M.
 - c. Wall Thickness: Conform to wall thickness specified in Section 40 05 05, Exposed Piping Installation, but in no case less than pipe wall thickness.
 - d. Base Fitting: Provide Type 316 stainless steel.

4. Threaded Connections: Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182/A182M or ASTM A276, shop welded to pipe at locations specified or shown.

B. Specials:

1. Pipe Adapters: Where necessary to join pipe of different type, provide necessary adapters. Ends shall conform to the Specifications for appropriate type joint.
2. Ball Valves
 - a. Products and Manufacturers: Provide the following:
 - 1) Nibco Inc.
 - 2) Or equal.
3. Duckbill Elastomeric Check Valves
 - a. Products and Manufacturers: Provide the following:
 - 1) Red Valve – Tideflex Series 35.
 - 2) Or equal.

C. Welding of Pipe:

1. Welding performed under this Section shall be completed in shop. Field welding is not allowed. Welding shall conform to AWS D1.6.
2. Stainless steel joining welds shall be made using fully automatic, inert gas process. Before welding longitudinal butt seal, starting and run-off tabs shall be heliarc spot welded to each end of pipe. Ends shall be checked for trueness to axis. Rigid jigs and fixtures shall be used for holding parts in proper alignment during welding.
3. During welding, joint shall be backed up from opposite side with chill bar. Chill bar shall have series of holes running its entire length through which gas is introduced to assure shielding to interior of joint. Welding of joint shall be by automatic arc, inert gas method. Gas shield shall be utilized top and bottom to assure that weld is made in completely inert atmosphere.
4. Filler wire shall be added to all gauges of material to provide cross section of weld metal equal to or greater than parent metal. Filler wire shall be at least one grade higher than parent metal and always of extra low carbon grade. Filler wire shall be automatically fed to weld with rate of travel of automatic welding machine. Use non-consumable tungsten electrode, with shielding gas being either argon or helium.
5. Welds shall be fully penetrated, sound, and of uniform bead. Circumferential welds shall be made using tungsten shielded arc process. Welds shall have full penetration to interior surface of pipe. Provide gas shielding to interior of joint as well as to exterior, to assure that weld is made in completely inert atmosphere.
6. Welds shall have surface finish equal to smoothness of 2D sheet finish. Interior weld beads shall be smooth, evenly distributed, with interior projection not exceeding 1/16-inch beyond inside diameter of pipe or fitting. Ripples or unevenness shall be finely ground to meet above requirements. Major grinding of interior seams to remove excess projection of welds or severe unevenness is not allowed.

7. Outside weld area shall be wire brushed. Brushes shall be of stainless steel and used only on stainless steel material. Exterior discoloration and deposits left by welding shall be removed mechanically with wire brushes or non-metallic abrasives.

2.3 FINAL CLEANING

- A. After fabrication, mechanically clean accessible weld surfaces with wire brushes or non-metallic abrasives.
- B. Pipe, fittings, and flanges shall be free of iron particulates and other foreign material.

2.4 IDENTIFICATION

- A. Pipe and fitting materials shall be stamped, marked, or identified with the following:
 1. Name of manufacturer.
 2. Date of manufacture.
 3. Operating design pressure at operating design temperature.
 4. Type of service.
 5. Manufacturer's part number.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

- A. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 53

PROCESS VALVES, FOUR-INCH DIAMETER AND LARGER

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install process valves, four-inch diameter and larger, and appurtenances, complete and operational.
- B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves Work.
- C. Related Sections:
1. Section 05 05 33, Anchor Systems.
 2. Section 09 91 00, Painting.
 3. Section 33 05 05, Buried Piping Installation.
 4. Section 40 05 05, Exposed Piping Installation.
- D. The following index of this Section is included for convenience:

Article Title

Part 1 - General

- 1.1 Description
- 1.2 References
- 1.3 Quality Assurance
- 1.4 Submittals
- 1.5 Delivery, Storage and Handling

Part 2 - Products

- 2.1 General
- 2.2 Eccentric Plug Valves
- 2.3 Swing Check Valves
- 2.4 Appurtenances for Exposed Metallic Valves
- 2.5 Anchorages and Mounting Hardware
- 2.6 Tools, Lubricants, and Spare Parts
- 2.7 Painting of Exposed Valves, Hydrants and Appurtenances
- 2.8 Inspection and Witness Shop Tests

Part 3 - Execution

- 3.1 Inspection
- 3.2 Installation
- 3.3 Field Quality Control

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Bearing Manufacturers Association (ABMA).
2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.34, Valves-Flanged, Threaded and Welding end. (ASME B16.34).
4. ANSI/NSF 61 Drinking Water Components – Health Effects.
5. API STD 594, Check Valves, Flanged Lug, Wafer and Butt-Welding.
6. API STD 598, Valve Inspection and Testing.
7. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
8. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
9. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
10. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
11. ASTM A276, Specification for Stainless Steel Bars and Shapes.
12. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
13. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
14. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
15. ASTM A536, Specification for Ductile Iron Castings.
16. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
17. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
18. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
19. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
20. ASTM B138/B138M, Specification for Manganese Bronze Rod, Bar and Shapes.
21. ASTM B265, Specification for Titanium and Titanium Alloy Strip, Sheet and Plate.

22. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
23. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
24. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
25. AWWA C540, Power-Actuating Devices for Valve and Slide Gates.
26. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
27. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid-Resistant.
28. NEMA MG 1, Motors and Generators.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.
 2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.
 3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the process valve manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Installation drawings showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
 - b. Calculations for sizing of operating mechanism with extension stems.
 - c. Calculations for sizing of gear actuators.
 2. Product Data:
 - a. Product data sheets.

- b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
 - c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
 - d. Cv values and hydraulic headloss curves.
 - 3. Samples:
 - a. If requested by ENGINEER, furnish one foot of chain for chainwheel-operated valves.
 - 4. Testing Plans:
 - a. Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.
- B. Informational Submittals: Submit the following:
- 1. Certificates:
 - a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by ENGINEER.
 - 2. Manufacturer Instructions:
 - a. Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for valves and appurtenances that require anchor bolts or similar anchorages.
 - 4. Source Quality Control Submittals:
 - a. Submit copies of shop test results and inspection data, certified by manufacturer.
 - 5. Field Quality Control Submittals:
 - a. Submit results of field tests required.
 - 6. Supplier's Reports:
 - a. When requested by ENGINEER, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
 - 7. Qualifications Statements:
 - a. When requested by ENGINEER, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.
- C. Closeout Submittals: Submit the following:
- 1. Operations and Maintenance Data:
 - a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
 - b. Furnish in operations and maintenance manuals complete nameplate data for each valve and electric actuator.

- D. Maintenance Material Submittals: Submit the following:
1. Spare Parts, Extra Stock Materials, and Tools:
 - a. Spare Parts and Extra Stock Materials: Furnish as specified for each valve type.
 - b. Tools: Furnish two sets of special tools (excluding metric tools, if applicable) for each size and type of valve furnished.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 2. Inspect boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
 3. Conform to Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Valves, General:
1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
 2. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
 - a. Valve size.
 - b. Pressure and temperature ratings.
 - c. Application (other than water and wastewater).
 - d. Date of manufacture.
 - e. Manufacturer's name.
 3. Provide valves to turn clockwise to close, unless otherwise specified.
 4. Provide valves with permanent markings for direction to open.

5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.

B. Valve Materials:

1. Valve materials shall be suitable for the associated valve's service or application, as shown.
2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
3. Wetted components and wetted surfaces of valves used with potable water or water that will be treated to become potable shall conform to ANSI/NSF 61.
4. Clean and descale fabricated stainless steel items in accordance with ASTM A380 and the following:
 - a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three percent hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.
 - b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic abrasive tools to remove weld discoloration, and then neutralize and wash clean.

C. Valve Joints:

1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
2. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
3. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 ECCENTRIC PLUG VALVES

A. Manufacturers: Provide products of one of the following:

1. DeZurik.
2. Or equal.

B. General:

1. Provide eccentric-type plug valves each with rectangular ports.
2. Minimum Rated Working Pressure:
 - a. Valves 12-inch Diameter and Smaller: 175 psig.
 - b. Valves 14-inch through 72-inch Diameter: 150 psig.
3. Maximum Fluid Temperature: 180 degrees F.
4. Minimum Port Area:
 - a. Valves 20-inch Diameter and Smaller: 100 percent of nominal pipe area.
5. Packing and packing gland shall be externally adjustable and accessible without disassembling valve and without removing the actuator.
6. Valves shall provide drip-tight, bi-directional shutoff at rated pressures.
7. Plug shall have cylindrical seating surface eccentrically offset from center of plug shaft. Interface between plug face and body seat, with plug in closed position, shall be externally adjustable in the field with valve in the line while under pressure.
8. Plug shall be supported to top bearing by using spring that is externally adjustable.
9. For sludge service, plug valves shall allow pigging of the piping with line-size pigs.

C. Materials of Construction:

1. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
2. Plug:
 - a. Core: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.
 - b. Plug Facing: Neoprene.
 - c. For valves up to eight-inch diameter, plugs shall be fully encapsulated with rubber. For valves larger than eight-inch diameter, provide plugs with rubber facing. Minimum thickness of rubber lining shall be 1/8-inch. Rubber hardness shall be a minimum of 70 (Shore A) durometer. Rubber-to-metal bond shall withstand minimum 75-pound pull conforming to ASTM D429 Method B.
3. Seats: Minimum 1/8-inch welded overlay of minimum 90 percent pure nickel on surfaces contacting plug face. Seats shall provide contact area of at least 1/2-inch width all around.
4. Stem Bearings: Sintered, oil impregnated, permanently lubricated of Type 316 stainless steel.
5. Stem Seal: Multiple neoprene V-ring type.
6. All internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts and washers shall be Type 316 stainless steel.

D. Interior Coating and Lining:

1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.
- E. Shop Testing:
1. Operational Tests:
 - a. To demonstrate that complete assembly is workable, successfully operate each valve (with actuator mounted directly on valve) three times from fully closed to fully open position and reverse under no-flow condition.
 2. Leakage Tests:
 - a. Test each valve for leaks while valve is in closed position.
 - b. Test valves at rated pressures. During test, valves shall be drip-tight. Test duration shall be at least five minutes for valves up to 20-inch diameter and ten minutes for valves larger than 20-inch diameter. Tests shall be repeated successfully with pressure in the unseating direction.
 3. Hydrostatic Test: Test valves to an internal hydrostatic pressure equivalent to twice rated pressure of valve. During hydrostatic test, there shall be no leakage through metal, end joints, and shaft seal, nor shall any part be permanently deformed. Duration of hydrostatic test shall be sufficient to allow visual examination for leakage. Test duration shall be at least one minute for valves eight-inch diameter and smaller, three minutes for valves 10-inch through 20-inch diameter, and ten minutes for valves 24-inch diameter and larger.
- F. Gear Actuators for Manually-operated Valves:
1. Provide gear actuators on buried and exposed valves, except valves four-inch diameter and smaller located less than five feet above operating floor. Gas service valves shall be provided with worm gear actuators.
 2. Size gear actuators for valves eight-inch diameter and smaller for 175 psig differential pressure.
 3. Size gear actuators for valves larger than eight-inch diameter for the following maximum differential pressures:
 - a. Valve Size and Location: 12-inch and 20-inch in Pump Room.
 - b. Maximum Differential Pressure Across Closed Valve: 5 psi.
 4. Provide actuators capable of holding associated valves in any intermediate position without creeping or vibrating.
 5. Provide valve position indicator on each actuator. Provide stop-limiting devices for open and closed position. For buried and submerged service actuators, provide position indicators in valve box.
 6. Provide adjustable stop to adjust seating pressure.
 7. Make packing accessible for adjustment without requiring removal of actuator from valve, except for valves in buried and submerged service.
 8. Diameter ratio of handwheel or chainwheel and gear sector shall be less than two.

9. For buried and submerged valves, gear actuator shall be grease-packed and designed to withstand submersion, and shall be drip-tight in water 20 feet deep, with self-adjusting packing.
10. Provide each actuator with gearing totally enclosed.
11. Operator shaft and gear sector shall be supported on permanently lubricated bronze or stainless steel bearings.
12. Provide metal-encased spring loaded seals in top and bottom covers of gear housing.
13. Actuators shall be provided to produce indicated torque with maximum pull of 40 pounds on handwheel or chainwheel and maximum input of 150-foot pounds on operating nuts, for both seating and unseating heads equal to maximum differential pressure rating of valve.
14. Actuator components between input and stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and input torque of 300-foot pound for operating nuts when operating against stops.
15. Materials of Construction:
 - a. Housing: Cast-iron, ASTM A126 Class B.
 - b. Gear Sector: Cast-iron ASTM A126 Class B, or ductile iron ASTM A536.
 - c. Worm Shaft: Steel, AISI 1144, hardened and tempered to an average Rc 40 and within range of Rc 35-45.
 - d. Bearings: Bronze oil-impregnated, or stainless steel.
 - e. Hardware, including bolts, nuts, washers, set screws, and pins, shall be Type 316 stainless steel.

2.3 SWING CHECK VALVES

- A. Manufacturers: Provide products of one of the following:
 1. APCO Willamette Valve & Primer Corp.
 2. Crispin Valve
 3. G.A. Industries.
- B. General:
 1. Provide valves conforming to AWWA C508 and as specified herein.
 2. Sizes: Four-inch through 24-inch diameter.
 3. Type: Resilient-seated.
 4. Rated Working Pressure:
 - a. Smaller than 12-inch Diameter: 175 psig.
 - b. 12-inch Diameter and Larger: 150 psig.
 5. Provide valves suitable for vertical mounting.
 6. Check valves shall have clear waterway with full-open area equal to nominal pipe size.
 7. Provide check valves with outside adjustable weight and lever.
 8. Provide valves larger than six-inch diameter with adjustable air cushion chambers.

9. Valve seats shall be mechanically attached and shall be field replaceable.
- C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
1. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
 2. Disc Arm: Ductile iron.
 3. Hinge Shaft: Type 316 stainless steel.
 4. Hinge Shaft Bushings: Bronze, or Type 316 stainless steel for sewage service.
 5. Shaft End Plate: Type 316 stainless steel.
 6. Body Seat: Type 316 stainless steel.
 7. Follower Ring for Rubber Seat on Disc: Type 316 stainless steel.
 8. Disc Center Pin Assembly: Type 316 stainless steel.
 9. Air Cushion Chamber:
 - a. Chamber and Plunger: Bronze.
 - b. Linkages and Pins: Type 316 stainless steel.
 - c. Air Check Valve and Tubing: Brass or stainless steel.
 10. Rubber Items:
 - a. Applications Up to 180-degree F Fluid Temperature: Buna-N or other synthetic rubber suitable for the application.
 - b. Applications 180-degrees F and Greater Fluid Temperature: Viton, or other synthetic rubber suitable for the application.
 11. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
 12. Gland Packing: Graphite and Kevlar.
- D. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.
- E. Testing:
1. Test each valve in manufacturer's shop in accordance with AWWA C508.
 2. Allowable Leakage at Rated Pressures: Zero.

2.4 APPURTENANCES FOR EXPOSED METALLIC VALVES

- A. General:
1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.
 2. For valves located five feet or more above operating floor, provide chain operators.
 3. Where indicated, provide extension stems and floorstands.

- B. Handwheels:
1. Conform to applicable AWWA standards.
 2. Material of Construction: Ductile iron, or cast aluminum.
 3. Arrow indicating direction of opening and word "OPEN" shall be cast on trim of handwheel.
 4. Maximum Handwheel Diameter: 2.5 feet.
- C. Chain Operators:
1. Chains shall extend to three feet above operating floor.
 2. Provide 1/2-inch stainless steel hook bolt to keep chain out of walking area.
 3. Materials of Construction:
 - a. Chain: Type 316L stainless steel.
 - b. Chainwheel: Recessed groove type made out of Type 316 stainless steel.
 - c. Guards and Guides: Type 316L stainless steel.
 4. Chain Construction:
 - a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends is unacceptable.
 5. Provide geared operators where required to position chainwheels in vertical position.
 6. Provide means to prevent chainwheel retaining nut from loosening. Use set screws or attachment bases with clamps to secure the Chainwheel to the valve handwheel.
- D. Crank Operator:
1. Crank operator shall be removable and fitted with rotating handle.
 2. Maximum Radius of Crank: 15 inches.
 3. Materials:
 - a. Crank: Cast-iron or ductile iron.
 - b. Handle: Type 304 stainless steel.
 - c. Hardware: Type 304 stainless steel.
- E. Extension Stems and Floor Stands for Gate Valves:
1. Conform to the applicable requirements of AWWA C501 for sizing of complete lifting mechanism.
 2. Bench and Pedestal Floor Stands:
 - a. For valves requiring extension stems, provide bench or pedestal floor stands with handwheel or crank as indicated. Provide provisions for using portable electric actuator for opening and closing of valves.
 - b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering housing. Provide lubrication fitting for grease. For valves conveying water that is potable or that will be treated to become potable, grease shall be food-grade and ANSI/NSF 61-listed. Base shall be machined.

- c. Materials of Construction:
 - 1) Housing: Cast-iron, ASTM A126, Class B.
 - 2) Lift Nut: Cast bronze, ASTM B98/B98M.
 - 3) Grease Fitting: Stainless steel.
 - 4) Bolting: Type 316 stainless steel.
- 3. Wall brackets for floor stands shall be Type 316L stainless steel construction.
- 4. Extension Stems:
 - a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
 - b. Maximum Slenderness Ratio (L/R): 100.
 - c. Minimum Diameter: 1.5-inch.
 - d. Threads: Acme.
 - e. Provide stem couplings where stems are furnished in more than one piece. Couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
 - f. Weld to bottom of extension stem a Type 316 stainless steel cap suitable for square end of valve stem.
- 5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
- 6. Stem Guides:
 - a. Material: Type 316 cast stainless steel with bronze bushing for stem. For submerged service, Type 316 cast stainless steel with stainless steel bushing for stem.
 - b. Maximum Stem Length Between Guides: Seven feet.
 - c. Stem guides shall be adjustable in two directions.
- 7. Furnish stem cover of clear butyrate plastic or Grade 153 Lexan with cast adapter for mounting cover to bench and floor stands. Provide stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within cover. Provide stem cover with mylar tape with legible markings showing valve position at one-inch intervals and open and close limits of valve.

- F. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.5 ANCHORAGES AND MOUNTING HARDWARE

- A. General:
 - 1. Comply with Section 05 05 33, Anchor Systems, except as modified in this Section.
 - 2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.
 - 3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.

4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.6 TOOLS, LUBRICANTS, AND SPARE PARTS

- A. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following Substantial Completion. Lubricants for equipment associated with conveying potable water or water that will be treated to become potable shall be food-grade and ANSI/NSF 61-listed.
- B. Tools, spare parts, and maintenance materials shall conform with Section 01 78 43, Spare Parts and Extra Materials.

2.7 PAINTING OF EXPOSED VALVES, HYDRANTS, AND APPURTENANCES

- A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface preparation, priming, finish painting, and field touch-up painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 1. Install valves and appurtenances in accordance with:
 - a. Supplier's instructions and the Contract Documents.
 - b. Requirements of applicable AWWA standards.
 - c. Applicable requirements of Section 40 05 05, Exposed Piping Installation.
 2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.

3. Position swing check valves and butterfly valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.
- B. Exposed Valves:
1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
 2. Operators:
 - a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
 - b. Avoid placing operators at angles to floors or walls.
 - c. Orient chain operators out of way of walking areas.
 - d. Install valves so that indicator arrows are visible from floor level.
 - e. For motor-operated valves located lower than five feet above operating floor, orient motor actuator to allow convenient access to pushbuttons and handwheel.
 3. Floor Stands and Stems:
 - a. Install floor stands as shown and as recommended by manufacturer.
 - b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.
 - c. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.
- C. Plug Valves:
1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
 2. Install plug valves that are in vertical liquid piping with plug at top when closed or as recommended by valve Supplier.
 3. Supplier shall tag or mark plug valves to indicate proper mounting position.

3.3 FIELD QUALITY CONTROL

- A. Field Tests:
1. Adjust all parts and components as required to provide correct operation of valves.
 2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
 3. Verify satisfactory operation and controls of motor operated valves.
 4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
 5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.

B. Supplier's Services:

1. Provide services of qualified factory-trained service technicians to check and approve installation of the following types of valves:
 - a. Plug and Check Valves.
2. Supplier's serviceman shall perform the following:
 - a. Instruct CONTRACTOR in installing equipment.
 - b. Supervise installation of equipment.
 - c. Inspect and adjust equipment after installation and ensure proper operation.
 - d. Instruct OWNER's personnel in operating and maintaining the equipment.
3. Manufacturer's representative shall make a minimum of four visits, with a minimum of eight hours onsite for each visit. First visit shall be for unloading supervision (if specified) and instruction of CONTRACTOR in installing equipment; second visit shall be for assistance in installing equipment; third visit shall be for checking completed installation and start-up of system; fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
4. Training: Furnish services of Supplier's qualified factory trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 40 05 86

AIR VALVES FOR WATER AND WASTEWATER SERVICE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, and test Air Valves for water and wastewater service complete with appurtenances.
 - 2. This Section does not include valves used for:
 - a. Plumbing.
 - b. Heating, ventilating, air conditioning, steam, or condensate systems.
 - c. Instrumentation.
 - 3. This Section does not include:
 - a. Valves specified in other Sections
 - b. Valves furnished with equipment
 - c. Non-metallic valves.
- B. Coordination:
 - 1. Review installation procedures for this and other Specification sections and coordinate Work that must be installed with or before Work under this Section.
- C. Related Sections:
 - 1. Section 09 91 00, Painting
 - 2. Section 40 05 53, Process Valves, Four-inch Diameter and Larger

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/AWWA C512, Air Release, Air Vacuum and Combination Air Valves for Waterworks Service
 - 2. ANSI/AWWA C550, Protective Interior Coatings for Valves and Hydrants.
 - 3. ANSI/NSF 61 Drinking Water Components – Health Effects

1.3 DEFINITIONS

- A. The following definitions apply to this Section.
 - 1. Air Release Valve: A hydromechanical device designed to automatically release to atmosphere small pockets of air as they accumulate in a pipeline when pipeline system is full and operating under pressure.
 - 2. Air/Vacuum Valve: Direct-acting, float-operated, hydromechanical device designed to automatically release or admit large volumes of air during filling or draining of a pipeline or piping system. Valve will open to relieve

negative pressures and will not reopen to vent air when system is full and under pressure.

3. Air Valve: Valve of one of the following types: Air Release Valve, Air/Vacuum Valve, or Combination Air Valve.
4. Combination Air Valve: Device having features of an Air Release Valve and Air/Vacuum Valve.
5. Maximum and Minimum Working Pressure: Pressure range at which valve is designed to function.
6. Orifice: Opening in valve mechanism through which air is expelled from or admitted into pipeline or piping system.
7. Valve Design Pressure: Maximum pressure to which a valve may be subjected without exceeding allowable stress of its components.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall be able to provide documentation of at least five installations of substantially similar equipment to that specified, in satisfactory operation for at least five years.

B. Component Supply and Compatibility:

1. Valves of the same type, including specified accessories, shall be products of or furnished by a single air valve manufacturer.

1.5 SUBMITTALS

A. Action Submittals.

1. Product Data: Submit the following for each type and size of valve specified:
 - a. Product data sheet.
 - b. Complete catalog information, including dimensions, weight, performance data, Orifice size, specifications, and identification of materials of each part.

B. Informational Submittals:

1. Certifications:
 - a. Submit a certificate signed by manufacturer of each product stating that product conforms to applicable referenced standards and specified requirements.
2. Test Reports:
 - a. Provide results of successful factory tests prior to shipping products to the Site.
3. Manufacturer's Reports:
 - a. Submit written report of results of each visit to Site by a manufacturer's serviceman, including purpose and time of visit, tasks performed, and results obtained.

C. Closeout Submittals.

1. Operation and Maintenance Data:
 - a. Submit complete operation and maintenance manual for all Air Valves in the Contract, including maintenance data and schedules in sufficient detail for disassembly and assembly of valve, and identifying parts that can be replaced.
 - b. Furnish operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
2. Spare Parts:
 - a. Provide spare parts and list of recommended spare parts as specified in this Section:

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 1. Prepare valves for shipping per Section 6.2 of ANSI/AWWA C512.
 2. Conform to Section 01 65 00, Product Delivery Requirements.
- B. Acceptance at Site:
 1. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
- C. Storage and Protection:
 1. Keep all products off ground using pallets, platforms, or other supports. Protect products from corrosion and deterioration.
 2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

1.7 MAINTENANCE

- A. Extra Materials
 1. Furnish one complete valve or set of field replaceable parts for each type and size of valve installed, tagged and boxed for long-term storage.
 2. Provide list of manufacturer's recommended spare parts, based on the quantity of each size and type of valve provided, including current pricing and delivery time. Provide recommendations for the number of spare valves based on the same criteria, including pricing and delivery time.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Extent:
 1. Provide valves included in this Section, per the schedule included in this Section and as shown on the Drawings.
- B. Requirements:

1. Valve Design Pressure: Unless otherwise specified, Valve Design Pressure shall be equal to or exceed design pressure of pipe or equipment on which the valve is installed.
 2. Valve Type, Service, Inlet Size, Orifice Size, Accessories, and Required Features: Provide per the schedule in this Section.
 3. Materials: Air Valve materials shall be suitable for long-term use in the service specified.
 4. Ends:
 - a. Provide per the schedule in this Section.
 - b. Comply with valve connection requirements in Section 4.3 of ANSI/AWWA C512.
 5. Operating Pressure Range: Valves shall be suitable for pressure range specified in the schedule in this Section. Valve Design Pressure shall be greater than the valve's Maximum and Minimum Working Pressure.
 6. Air Valves in water service shall comply with ANSI/AWWA C512 unless otherwise shown or specified.
- C. Markings:
1. Mark valves per Section 6.1 of ANSI/AWWA C512.
- D. Manufacturers and Model Numbers:
1. Valve manufacturers and model numbers are in the schedule included in this Section.

2.2 ACCESSORIES

- A. Isolating Valves:
1. Provide isolating valves in the schedule included in this Section and as shown. Isolating valves shall conform to applicable requirements of Sections 40 05 23, Stainless Steel Process Pipe for Liquid Service.
 2. Valve Design Pressure of isolating valve shall equal or exceed Valve Design Pressure of the connected Air Valve.
- B. Discharge Pipe and Backflow Prevention:
1. Route discharge of air release valve to the Wet Well and provide backflow prevention at termination as required by Sections 40 05 23, Stainless Steel Process Pipe for Liquid Service.
- C. Back-flush Attachments:
1. Unless otherwise indicated, provide back-flush attachment for Air Valves in sewage service.
 2. Back-flush attachments shall be as normally furnished by specified Air Valve manufacturer. Provide ports in the Air Valve body for flushing and discharge, each with an isolating valve and quick-connect for attaching hoses.
 3. Provide five-foot length of rubber hose with quick-connect for connecting to flushing discharge port.

4. Provide a plugged 2-inch diameter NPT port at bottom of Air Valve body for removal of solids.

2.3 FACTORY PAINTING

A. Interior Surfaces

1. Extent: Paint ferrous surfaces except stainless steel surfaces.
2. Paint: Paint shall be as normally provided by Air Valve manufacturer for the specified application, except for potable water service valves which shall be coated with paint complying with ANSI/AWWA C550 and ANSI/NSF-61.

B. Exterior Surfaces

1. Exterior surfaces of cast-iron, ductile iron, and steel other than stainless steel, except machined surfaces of valves and appurtenances, shall be finish painted.
2. Surface preparation, painting, and field touch-up painting shall be per Section 09 91 00, Painting.
3. Furnish valve with only a prime coat if so indicated.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect Air Valves per Section 5 of ANSI/AWWA C512. Do not ship valves that are not successfully tested.

PART 3- EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected.
- B. Examine valves and remove packing and foreign materials from interior of valve. Report defects to ENGINEER

3.2 INSTALLATION

- A. Install valves and appurtenances as shown on the Drawings and per Air Valve manufacturer's recommendations, approved Shop Drawings, and applicable codes and standards.
- B. Install valves plumb and vertical.
- C. Install with an isolating valve. Remove isolating valve's operating handle or lever and deliver to OWNER.

- D. Adjust throttling devices, if provided, for smooth, non-slam and waterhammer-free operation.

3.4 SCHEDULE

- A. The schedules listed below, following the “End of Section” designation, are a part of this Specification section.
 - 1. Table 40 05 86-A, Air Valve Schedule.

+ + END OF SECTION + +

TABLE 40 05 86-A AIR VALVE SCHEDULE

No.	Valve Type	Service	Location	Inlet Dia. (inch)	Inlet Connect'n Type	Orifice (inch)	Working Pressure Range (psi)	Valve Design Pressure (psi)	Isolating Valve Type	Accessories	Mfr. & Model*	Req'd Features
1	AR	WW	D	2	NPT	3/16	15 - 60	150	BA	BF	VM 48A, GA 925	(4)
2	CA	WW	Force Main – Manhole at Intersection of Lake Street and Summit Street	2	NPT	3/16	15 - 60	150	BA	BF	VM 803A	(2)
3	CA	WW	Force Main – Manhole at Intersection of Seltsam Road and Dale Street	2	NPT	3/16	15 - 60	150	BA	BF	VM 803A	(2)

* Valves shall be the Supplier's models shown or equal.

Abbreviations that may be used in the Schedule:

Valve Type

Air Release Valve	AR
Air/Vacuum Valve	AV
Combination Air Valve	CA

Service

Water (non-potable)	WAT
Potable Water	PW
Waste Water	WW

Inlet Connection

Flanged	F
Threaded	NPT

Isolating Valve Type

Ball Valve	BA
Butterfly Valve	BU
Plug Valve	PL
Gate Valve	GV

Accessories

Vacuum Check	VC
Throttling Device	TD
Anti-slam Device	SV
Outlet Cowl or Hood	OC
Inflow Prevention Device	IP
Backflush Attachments	BF

Manufacturer

Val-Matic	VM
GA Industries	GA
Crispin	CR
Valve and Primer	APCO

Location

As shown on Drawings	D

Required Features

- Cast stainless steel body and cover (1)
- Fusion bonded exterior coating (2)
- Backflush attachments not required for
 Air Valve in wastewater service (3)
- Exterior surface to be painted with prime coat only (4)

++ NO TEXT ON THIS PAGE ++

SECTION 40 05 96

VIBRATION, SEISMIC, AND WIND CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all professional services, labor, materials, tools, equipment, and incidentals as shown, specified, and required to design, furnish, and install Vibration Control, Seismic Control, and Wind Control for Process Mechanical, HVAC, plumbing, electrical, instrumentation and control, and architectural Components.
2. Extent of Components requiring Controls are described in this Section and as required by Laws and Regulations. The Work includes:
 - a. Vibration Controls for Components.
 - b. Seismic Controls for architectural Components, including entry of services to buildings, including piping and conduit up to but not including utility connection point.
 - c. Wind Controls for Components.
3. The Work excludes:
 - a. Seismic Controls are not required for this project except as noted above. Information contained in this specification pertaining to Seismic Controls shall not apply except as noted for architectural Components.
 - b. Designing Controls for piping larger than 24-inch diameter.

B. Coordination:

1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before Controls.

C. Related Sections:

1. Section 01 45 33, Code-Required Special Inspections Procedures
2. Section 05 05 33, Anchor Systems.
3. Section 05 50 13, Miscellaneous Metal Fabrications.
4. Section 09 91 00, Painting.
5. Section 10 14 00, Signage.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AWS D1.1, Structural Welding Code – Steel.
2. AWS D1.2, Structural Welding Code – Aluminum.
3. AWS D1.3, Structural Welding Code – Sheet Steel.
4. AWS D1.6, Structural Welding Code – Stainless Steel.

5. Ceilings and Interior Systems Construction Association (CISCA), CISCA 0-2, Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings, Seismic Zones 0-2
6. CISCA 3-4, Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings, Seismic Zones 3-4
7. National Roofing Contractors Association (NRCA) Standards.

1.3 DEFINITIONS

- A. The following definitions are used in this Section:
1. Certificate of Compliance: Certificate provided by Component manufacturer indicating that Component has been tested or analyzed in accordance with Laws and Regulations, including applicable building code, and is capable of resisting design forces defined in Laws and Regulations.
 2. Components: Process Mechanical, HVAC, plumbing, electrical, instrumentation and control, architectural, and other non-structural equipment, systems, and elements permanently attached to structures, including supporting structures and attachments.
 3. Component Assembly: Component assembled by CONTRACTOR from individual components of different Suppliers.
 4. Controls: Vibration Control, Seismic Control, and Wind Control.
 5. Controls Design Engineer: Professional engineer responsible for Vibration Control, Seismic Control, and Wind Control.
 6. Essential Facility: Buildings and other structures intended to remain operational in event of extreme environmental loading from flood, wind, snow, or earthquakes.
 7. Failure: Separation of an attachment between Components, or Components and structure, vertical permanent deformation greater than 1/8-inch, horizontal permanent deformation greater than 1/4-inch, or failure of the equipment to perform its function.
 8. Hazardous Contents: Material that is highly toxic or potentially explosive in sufficient quantity to pose significant life-safety threat to personnel working in building or the general public if an uncontrolled release were to occur.
 9. Importance Factor (Ip): Factor that accounts for degree of hazard to human life and damage to property.
 10. Isolated Component: Component indirectly connected to structure through Control designed to prevent transmission of Component vibration to structure.
 11. Lateral Forces: Horizontally applied forces resulting from wind or seismic event, combined with operational horizontal forces. Wind and seismic forces are considered separately.
 12. Life Safety Systems: All systems involved with fire protection including sprinkler piping, water service piping, jockey pumps, fire pumps, fire dampers, smoke dampers, smoke exhaust systems, control panels and fire alarm panels associated with fire protection Components, and Components in Essential Facilities necessary for keeping the Essential Facility Operational.

13. Non-Isolated Component: Component that is connected to structure in such a way that allows transmission of Component vibration to structure.
14. Operational: Capable of providing intended function.
15. Process Mechanical: All mechanical Components that are not part of HVAC, plumbing and fire protection Components.
16. Seismic Control: Seismic restraining systems.
17. Seismic Use Group: Classification assigned to building based on use defined in applicable building code.
18. Vibration Control: Vibration isolating systems.
19. Wind Control: Wind restraining systems.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Supplier:
 - a. Minimum of five years of experience producing Controls substantially similar to those specified in the Contract Documents and able to provide evidence of at least five installations in satisfactory operation for at least five years in the United States.
 - b. Design and analysis delegated through Supplier shall be performed by a registered professional engineer licensed in same state as the Site.
2. Controls Design Engineer:
 - a. Engage registered professional engineer licensed in same state as the Site, who has a minimum of five years of experience in providing engineering services for Vibration, Seismic, and Wind Controls.
 - b. Submit qualifications data and include professional liability insurance certificate in amount of at least \$1,000,000 per claim/aggregate with maximum deductible of \$100,000.
 - c. Responsibilities include:
 - 1) Reviewing performance and design criteria for Controls specified in the Contract Documents.
 - 2) Determining sizes and locations of Controls.
 - 3) Preparing or supervising preparation of design calculations and related drawings, Shop Drawings and submittals, testing plan development, test result interpretation, and comprehensive engineering analysis verifying compliance of Controls with the Contract Documents.
 - 4) Signing and sealing all calculations, design drawings, and Shop Drawings.
 - 5) Certifying that:
 - a) Design of Controls was performed in accordance with performance and design criteria stated in the Contract Documents.
 - b) Design conforms to Laws and Regulations, and to prevailing standards of practice.
 - 6) Provide installation instructions and drawings.

- 7) Provide field quality control in accordance with Paragraph 3.3 of this Section.
 3. Installer:
 - a. Engage an experienced installer to perform the Work of this Section who specializes in installing Controls similar to that required for this Project.
 - b. Submit name and qualifications to ENGINEER with the following information on a minimum of three completed, successful projects:
 - 1) Names and telephone numbers of owners, and architects or engineers responsible for project.
 - 2) Approximate cost of Control work for which installer was responsible.
 4. Welder:
 - a. Qualify welding processes and welding operators in accordance with AWS D1.1, D1.2, D1.3, and D1.6 as appropriate for material to be welded.
 - b. Provide certification that welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.
- B. Requirements for special inspections are in Section 01 45 33, Code-Required Special Inspections Procedures.

1.5 SUBMITTALS

- A. Informational Submittals: Submit the following:
1. Shop Drawings:
 - a. Detailed schedules of flexible and rigidly mounted Components to receive Controls. Schedules shall be numbered and include Contract Drawing number references where Component is located.
 - b. Fabrication details of Component bases including dimensions, structural member sizes, support point locations, and weight distribution.
 - c. Specific details of Controls and anchorages, including number, size, and locations for each Component.
 - d. Details of suspension and support for ceiling-hung Components.
 - e. Details of attachment methods where walls, floors, slabs, or supplementary steel work are used for restraint attachment.
 - f. Location of all attachment and support points and forces transferred to supporting structure at each location, as a result of each load combination of static forces and Lateral Forces.
 - g. Detailed piping, ductwork, and conduit restraining system layout drawings showing their attachment to building or structure. Include dimensions, size, and location of restraints and attachment connections. Coordinate with system layout Shop Drawings provided under other Sections, as applicable.
 - h. Where Seismic Controls exclusions are allowed in applicable building code, identify in writing proposed exclusions to be taken and include a reference to the building code section and paragraph.

2. Product Data:
 - a. Supplier and model of Controls.
 - b. Supplier's literature, performance data, weight, illustrations, specifications, identification of materials of construction, dimensions of individual parts, and finishes.
 - c. Setting drawings, templates, and directions for installation of anchor bolts and other anchorages.
3. Certifications:
 - a. Component Certificates of Compliance: Where Component Suppliers are required by Laws and Regulations to provide a Certificate of Compliance for Components, submit the following:
 - 1) Component Certificate of Compliance from an agency that is accepted by authority having jurisdiction for compliance with building code. Analytical or shaker test certification shall be based on Project-specific seismic forces applied at Component's center of gravity, verifying capacity to transfer forces in continuous load path to supporting structure. Certification shall include design of anchorage or attachment to the supporting structure and post-seismic Operational capability. Submittals will not be reviewed without a Certificate of Compliance.
 - b. Provide completed Professional Design Services Performance Certification on Attachment A to this Section.
 - c. Controls Design Engineer's professional liability insurance certificate per Paragraph 1.4.A.2.b of this Section.
4. Delegated Design Submittals:
 - a. Information required to clearly demonstrate basis of design for Controls, including calculations, design dimensions, approach and assumptions, and Laws and Regulations on which design of Controls and anchorage is based. Design documents prepared by Controls Design Engineer shall bear the seal and original signature and date of the Controls Design Engineer. State of engineer's registration, name, and license number shall be clearly legible on the seal.
5. Test Reports:
 - a. Component test reports to confirm statements made on Certificate of Compliance, for Components where a Certificate of Compliance is required.
 - b. Test reports substantiating seismic restraint designs when calculations are not used.
6. Supplier's Instructions:
 - a. Instructions for shipping, storage protection, handling, and installation.
 - b. Routine maintenance requirements prior to start-up.
7. Field Quality Control Submittals:
 - a. Supplier's Field Reports: Submit reports confirming that Controls have been installed in accordance with Supplier's recommendations and approved Shop Drawings and submittals.
 - b. Controls Design Engineer Report: Submit report confirming that Controls

have been installed in accordance with the Controls design. Report shall bear the professional engineering seal, date, and original signature of the Controls Design Engineer.

8. Qualifications Statements: Submit qualifications for.
 - a. Supplier
 - b. Controls Design Engineer
 - c. Installer
 - d. Welder

B. Closeout Submittals:

1. Operation and Maintenance Data:
 - a. Submit complete operation, and maintenance manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Conform to Section 01 78 23, Operations and Maintenance Data.

PART 2 - PRODUCTS.

2.1 SYSTEM PERFORMANCE

A. System Description:

1. Schedules in Part 3 of this Section describe Components that are to receive Vibration Control and systems to receive Seismic Control.
2. Tables in Part 3 and performance criteria specified in Paragraph 2.1.C of this Section describe Controls to be provided on Components and systems described in the schedules. Tables are general in nature and may include certain Components that may not be specified in the schedules to receive Controls, while the schedules are Project-specific.
3. Where Components are subject to wind, design Component and related anchorage to supporting structure to resist wind loads per applicable building code using wind load factors indicated on structural Drawings. Using guy wires is allowed for assisting in support of Components.
4. Design of Components, including Vibration Controls provided by Component Supplier if required, and associated anchorage to supporting structure, are delegated through Supplier. Design shall resist seismic forces according to requirements of Laws and Regulations using seismic load factors indicated on structural Drawings. Design shall demonstrate that Component is capable of transferring Project-specific seismic forces (at minimum) applied at Component's center of gravity, and center of gravity of Component's major elements, to supporting structure without losing structural integrity.
5. Interconnection design of Component Assemblies, including Vibration Controls if required, and anchorage to supporting structure, shall be by Controls Design Engineer. Design of individual Components within assembly to resist seismic forces is responsibility of individual Component Supplier. Component Assembly design shall resist seismic forces according to

requirements of Laws and Regulations using seismic load factors indicated on structural Drawings. Design shall demonstrate that Component Assembly is capable of transferring Project-specific seismic forces (at minimum) applied at Component's center of gravity, and center of gravity of Component's major elements, to supporting structure without losing structural integrity. Coordinate design with each Supplier of Components used in the assembly and obtain approval of each Supplier prior to providing Shop Drawings for Component Assembly.

6. Equivalency: Products or methods specified for Controls are not intended to limit use of other products or methods of equivalent or superior quality and effectiveness.

B. Design Criteria:

1. Determine seismic design loads as stipulated in the building code. Lateral Force design information is included on the structural Drawings. Factored strength design seismic forces acting on a Component, per building code, shall be determined by calculation for each Component, considering all factors of Laws and Regulations.
2. Determine vertical seismic forces based on acceleration equal to two-thirds of building code-defined horizontal acceleration. Combine vertical seismic forces with horizontal seismic forces based on square root of sum of squares method.
3. Testing or calculations to support seismic restraint designs shall include shear, flexural, and axial loads, and at least one test or analyses at 45 degrees to weakest mode.
4. Analyses for anchorage shall include calculated dead loads, Lateral Forces, and capacity of materials utilized for connections to Components and structure. Analysis for anchorage shall include anchoring methods, bolt diameter, embedment, and weld requirements. Design Seismic Controls to accept, without failure, forces acting through Component's center of gravity and distributed relative to Component's mass distribution.
5. Design Wind Controls to accept, without failure, wind forces acting on Component's exposed wind surface area. Analyses for wind forces shall consider Lateral Forces applied on a minimum of two orthogonal axes in two directions per axis. Overturning moments may result in uplift forces that exceed gravitational forces at ground level that shall be incorporated into analysis.
6. Components are to remain in place during a seismic event. Where Hazardous Materials are contained in Components such as certain tanks and piping, Components and related systems shall be designed to prevent rupture.

C. Performance Criteria:

1. Design and provide Components to maintain structural integrity and to provide continuous load path to transfer Lateral Forces through elements of Component and through anchorage to supporting structure.
2. Fan and compressor Components shall be protected against excessive displacement that results from high air thrust in relation to Component weight.

Horizontal thrust restraints shall be provided when horizontal motion exceeds 3/8-inch.

3. Internally Isolated Components, when provided in lieu of external isolation and restraint systems, shall conform to requirements of this Section.
4. Curb or roof rail-mounted Components shall be attached to the curb or rails that shall, in turn, be attached to supporting structure, creating continuous load path for vertical and Lateral Forces. Sheet metal screw attachment is unacceptable.
5. Where location and characteristics of elements of supporting structure are not appropriate for supporting Component and transferring vertical and Lateral Forces, notify ENGINEER in writing.
6. Where changes in specified Components or location of Components are proposed by CONTRACTOR for convenience of CONTRACTOR and accepted by ENGINEER, modifications to supporting structure required by such changes shall be responsibility of CONTRACTOR at no additional cost to OWNER. Design of modification shall consider all vertical and Lateral Forces and be signed, dated, and sealed by Controls Design Engineer.
7. Where ceilings are not braced, lighting fixtures shall have independent four corner diagonal wire ties to structure.
8. Design lay-in ceilings, including accessory Components, in accordance with CISCA 0-2 or CISCA 3-4, as applicable.
9. Seismic Restraint of Piping:
 - a. For Isolated piping use Type V seismic cable restraints or resilient single arm braces. For piping that is not Isolated, use Type V seismic cable restraints or Type VI seismic solid braces.
 - b. Maximum seismic bracing distances are specified in Table 40 05 96-E in this Section. Fuel oil, natural gas piping, thermoplastic piping, and glass-lined pipe are exceptions to requirements of Table 40 05 96-E. Fuel oil and natural gas piping transverse restraints shall be at maximum intervals of 20 feet and longitudinal restraints at maximum intervals of 40 feet. Brace thermoplastic and glass-lined pipe with bottom shields at maximum intervals of 20 feet transversely and 40 feet longitudinally.
 - c. Determine by calculation required bracing distances when multiple runs of pipe are located on same support.
 - d. Use hanger rod braces when hanger rod lengths are greater than three feet.
 - e. Provide spacers inside clevis hangers at seismic brace locations.
 - f. Where thermal expansion guides and anchors are provided, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than restraint loads plus loads induced by expansion and contraction.
 - g. Transverse restraints for one pipe section may also act as longitudinal restraint for another pipe section of same size connected perpendicular to it if restraint is installed within two feet of elbow or tee, or combined stresses are within allowable limits at longer distances.

- h. Use hold-down clamps to attach pipe to trapeze members before applying restraints. Use Type V or VII restraint, if trapeze is smaller than 48 inches wide.
- i. Do not use smaller piping to restrain larger pipe.
- j. Fire protection branch piping shall be end-tied and seismically restrained.
- 10. Seismic Restraint of Electrical Conduit, Bus Duct, and Cable Tray:
 - a. For Components not Isolated, use Type V seismic cable restraints or Type VI seismic solid braces.
 - b. Maximum seismic bracing distances are specified in Table 40 05 96-E in this Section.
 - c. Determine by calculation bracing distances for multiple runs of conduit on same support.
 - d. Use hanger rod braces when hanger rod lengths are greater than three feet.
 - e. Use hold-down clamps to attach conduits to trapeze members before applying restraints. Use Type V or VII restraint, if trapeze is smaller than 48 inches wide.
- 11. Seismic Restraint of HVAC Ductwork:
 - a. Provide Type V seismic cable restraints or Type VI seismic solid braces.
 - b. Maximum bracing distances are specified in Table 40 05 96-E of this Section.
 - c. Reinforce ductwork at restraint locations. Reinforcement shall consist of an additional angle on top of ductwork that is attached to support hanger rods. Attach ductwork to both upper angle and lower trapeze.
 - d. A group of ducts may be combined in a larger frame so that combined weights and dimensions of ducts are less than or equal to maximum weight and dimensions of duct for which bracing details are selected.
 - e. Walls, including gypsum board used for non-bearing partitions, that have duct penetrations may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between duct and frame.
 - f. Support and laterally brace independent of duct system Components with an operating weight greater than 75 pounds installed in ductwork.
- D. Seismic Control Exclusions
 - 1. Exclusions for Seismic Control of Components per building code are allowed, except where noted otherwise in the Contract Documents.

2.2 MANUFACTURERS

- A. Provide products of one of the following:
 - 1. Vibration Mountings and Controls, Inc.
 - 2. Mason Industries
 - 3. Kinetics Noise Control
 - 4. Amber/Booth Company, Inc.
 - 5. Or approved equal

2.3 VIBRATION ISOLATION TYPES

- A. Type A: Spring Isolator - Free Standing
 - 1. Spring isolators shall be free standing and laterally stable without housing, and complete with a molded neoprene cup or 1/4-inch neoprene acoustical friction pad between baseplate and support.
 - 2. Mountings shall have leveling bolts rigidly bolted to the Component.
 - 3. Spring diameters shall be no less than 0.8 of compressed height of spring at rated load.
 - 4. Springs shall have minimum additional travel to solid equal to 50 percent of rated deflection.
 - 5. Product and Manufacturer: Provide one of the following:
 - a. ASC, manufactured by Vibration Mountings and Controls.
 - b. SLF, manufactured by Mason Industries.
 - c. Or approved equal.
- B. Type B: Seismically Restrained Spring Isolator
 - 1. Restrained spring mountings shall have Type A spring isolator within rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. Housing shall serve as blocking during erection. Remove steel spacer after adjustment. Installed and operating heights are equal. Provide minimum clearance of 1/4-inch around restraining bolts and internal neoprene deceleration bushings to avoid interfering with spring action. Limit stops shall be out of contact during normal operation. Because housings shall be bolted or welded in position, provide an internal isolation pad. Design housing to resist seismic forces.
 - 2. Product and Manufacturer: Provide one of the following:
 - a. AWRS, ASCM, manufactured by Vibration Mountings and Controls.
 - b. SLR, manufactured by Mason Industries.
 - c. Or approved equal.
- C. Type C: Combination Spring/Elastomer Hanger Isolator (30-degree Type)
 - 1. Hangers shall consist of rigid steel frames containing minimum 1.25-inch thick neoprene elements at top and steel spring with general characteristics specified for Type A. Neoprene element shall have neoprene bushings projecting through steel box.
 - 2. Spring diameters and hanger box lower hole sizes shall be large enough to allow hanger rod to swing through a 30-degree arc from side to side before contacting rod bushing and short-circuiting the spring.
 - 3. Submittals shall include hanger drawing showing 30-degree capabilities.

4. Hanger locations requiring pre-compression for holding piping at fixed elevation shall be pre-compressed by manufacturer.
5. Product and Manufacturer: Provide one of the following:
 - a. RSH30, manufactured by Vibration Mountings and Controls.
 - b. 30N, manufactured by Mason Industries.
 - c. Or approved equal.

D. Type D: Elastomer Double Deflection Hanger Isolator

1. Molded neoprene element, minimum 1.25-inch thick, with Projecting bushing lining rod clearance hole. Static deflection at rated load shall be minimum of 0.35 inches.
2. Steel retainer box encasing neoprene mounting capable of supporting Component up to four times rated capacity of element.
3. Product and Manufacturer: Provide one of the following:
 - a. RHD, manufactured by Vibration Mountings and Controls.
 - b. HD, manufactured by Mason Industries.
 - c. Or approved equal.

E. Type E: Combination Spring/Elastomer Hanger Isolator

1. Spring and neoprene elements in a steel retainer box with the features as specified in this Section for Type C and Type D isolators.
2. Hanger locations requiring pre-compression for holding piping at fixed elevation shall be pre-compressed by manufacturer.
3. Thirty-degree angularity feature is not required.
4. Product and Manufacturer: Provide one of the following:
 - a. RSH, manufactured by Vibration Mountings and Controls.
 - b. DNHS, manufactured by Mason Industries.
 - c. Or approved equal.

F. Type F: Seismically Restrained Elastomer Floor Isolator

1. Neoprene mountings shall have minimum static deflection of 0.2 inches and all-directional seismic capability. Mount shall consist of two separated and opposing molded neoprene elements. Elements shall prevent central threaded sleeve and attachment bolt from contacting casting during normal operation. Shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.
2. Product and Manufacturer: Provide one of the following:
 - a. RSM, manufactured by Vibration Mountings and Controls.
 - b. BR, manufactured by Mason Industries.
 - c. Or approved equal.

G. Type G: Pad Type Elastomer Isolator (Standard)

1. One layer of 3/4-inch thick neoprene pad consisting of two-inch square modules.

2. Use load distribution plates as required.
3. Provide bolting for seismic compliance. Provide neoprene and duck washers and bushings to prevent short circuiting.
4. Product and Manufacturer: Provide one of the following:
 - a. Maxiflex, manufactured by Vibration Mountings and Controls.
 - b. Super W, manufactured by Mason Industries.
 - c. Or approved equal.

H. Type H: Pad Type Elastomer Isolator (High Density)

1. Laminated canvas duck and neoprene, minimum 1/2-inch thick, with loading capacity of 1,000 psi.
2. Use load distribution plate as required.
3. Bolting as required for seismic compliance. Provide neoprene and duck washers and bushings to prevent short circuiting.
4. Product and Manufacturer: Provide one of the following:
 - a. Fabriflex, manufactured by Vibration Mountings and Controls.
 - b. HL, manufactured by Mason Industries.
 - c. Or approved equal.

I. Type I: Thrust Restraints

1. Spring element similar to that specified for Type A isolator shall be combined with steel angles, backup plates, threaded rod, washers, and nuts to produce a pair of devices capable of limiting movement of Components to 1/4-inch.
2. Restraint shall be easily converted in field from compression type to tension type.
3. Unit shall be factory pre-compressed.
4. Product and Manufacturer: Provide one of the following:
 - a. RSHTR, manufactured by Vibration Mountings and Controls.
 - b. WBI \ D, manufactured by Mason Industries.
 - c. Or approved equal.

J. Type J: Pipe Anchors

1. Provide all-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by minimum 1/2-inch thick 60-durometer neoprene.
2. Allowable loads on isolation material shall not exceed 500 psi. Balance design for equal resistance in all directions.
3. Product and Manufacturer: Provide one of the following:
 - a. MDPA, manufactured by Vibration Mountings and Controls.
 - b. ADA, manufactured by Mason Industries.
 - c. Or approved equal.

K. Type K: Pipe Guides

1. Pipe guides shall consist of telescopic arrangement of two sizes of steel tubing separated by minimum 1/2-inch thick 60-durometer neoprene.
 2. Height of guides shall be pre-set with shear pin to allow vertical motion induced by pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow selection of pipe movement.
 3. Guides shall be capable of minimum 1-5/8-inch motion in both directions
 4. Product and Manufacturer: Provide one of the following:
 - a. PG, manufactured by Vibration Mountings and Controls.
 - b. VSG, manufactured by Mason Industries.
 - c. Or approved equal.
- L. Type L: Isolated Pipe Hanger System
1. Provide pre-compressed spring and elastomer isolation hanger combined with pipe support into one assembly. Replaces standard clevis, single or double rod roller, or double rod fixed support.
 2. Provide with spring element specified for Type A, with steel lower spring retainer and upper elastomer retainer cup with integral bushing to insulate support rod from isolation hanger.
 3. Neoprene element under lower steel spring retainer shall have integral bushing to insulate support rod from steel spring retainer.
 4. Design and construct hangers to support loads over three times the rated load without Failure.
 5. System shall be pre-compressed to allow for rod insertion and standard leveling.
 6. Product and Manufacturer: Provide one of the following:
 - a. CIH, CIR, TIH, PIH, manufactured by Vibration Mountings and Controls.
 - b. Or approved equal.

2.4 SEISMIC RESTRAINT TYPES

- A. Type I: Spring Isolator, Restrained
1. Refer to vibration isolation Type B.
 2. Product and Manufacturer: Provide one of the following:
 - a. ASCM, AWR, manufactured by Vibration Mountings and Controls.
 - b. SLR, SLRS, manufactured by Mason Industries.
 - c. Or approved equal.
- B. Type II: Seismically Restrained Elastomer Floor Isolator
1. Refer to vibration isolation Type F.
 2. Product and Manufacturer: Provide one of the following:
 - a. RSM, manufactured by Vibration Mountings and Controls.
 - b. BR, manufactured by Mason Industries.

c. Or approved equal.

C. Type III: All-Directional Seismic Snubber

1. All-directional seismic snubbers shall consist of interlocking steel members restrained by one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and minimum of 1/4-inch thick. Rated loadings shall not exceed 1,000 psi. Minimum air gap of 1/8-inch shall be incorporated in snubber in all directions before contact is made between rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated.
2. Product and Manufacturer: Provide one of the following:
 - a. Type SR, manufactured by Vibration Mountings and Controls.
 - b. Z1225, manufactured by Mason Industries.
 - c. Or approved equal.

D. Type IV: Floor or Roof Anchorage

1. Rigid attachment to structure utilizing wedge-type anchor bolts, anchored plates machine screw, bolting or welding. Powder shots are unacceptable.
2. Product and Manufacturer: Provide one of the following:
 - a. FA, manufactured by Vibration Mountings and Controls.
 - b. SAB, manufactured by Mason Industries.
 - c. Or approved equal.

E. Type V: Seismic Cable Restraints

1. Seismic Cable Restraints shall consist of steel aircraft cables sized to resist seismic loads with minimum safety factor of 2.0, and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables shall not bend across sharp edges. Single arm braces with resilient bushings can be substituted for seismic cable restraints. Deck fitting shall have two through-bolts for attachment.
2. Product and Manufacturer: Provide one of the following:
 - a. SCR, manufactured by Vibration Mountings and Controls.
 - b. SCB, manufactured by Mason Industries.
 - c. Or approved equal.

F. Type VI: Rigid Arm Brace

1. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with minimum safety factor of 2.0, and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to final installation angle and utilize two through-bolts to provide attachment.
2. Product and Manufacturer: Provide one of the following:

- a. SAB, manufactured by Vibration Mountings and Controls.
- b. SSB, manufactured by Mason Industries.
- c. Or approved equal.

G. Type VII: Internal Clevis Cross Brace

- 1. Internal clevis cross braces at seismic locations shall be pre-cut pipe sized for internal clevis dimensions.
- 2. Product and Manufacturer: Provide one of the following:
 - a. ICB, manufactured by Vibration Mountings and Controls.
 - b. CCB, manufactured by Mason Industries.
 - c. Or approved equal.

2.5 COMPONENT BASES

A. General

- 1. All curbs and roof rails shall be anchored to building structural steel for resisting Lateral Forces. Fastening to metal deck is unacceptable.

B. Type B-1: Integral Structural Steel Base

- 1. Rectangular bases are preferred for all Components.
- 2. Centrifugal refrigeration machines and pump bases may be T- or L-shaped when there are space constraints. When the pump has pump-mounted suction and discharge fittings, base of pump shall include required supports.
- 3. All perimeter members shall be steel beams with minimum depth equal to 1/12 of the longest dimension of base.
- 4. Base depth need not exceed 12 inches provided that deflection and misalignment is within acceptable limits as determined by Supplier.
- 5. Height-saving brackets shall be employed on all mounting locations to provide minimum base clearance of two inches.
- 6. Product and Manufacturer: Provide one of the following:
 - a. WFB, manufactured by Vibration Mountings and Controls.
 - b. MSL, WSFL, manufactured by Mason Industries.
 - c. Or approved equal.

C. Type B-2: Concrete Inertia Base

- 1. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations.
- 2. When pump has pump-mounted suction and discharge fittings, base of pump shall include required supports
- 3. Base depth shall be a minimum of 1/12 of the longest dimension of the base but not less than six inches.
- 4. Base depth need not exceed 12 inches unless specifically recommended by base manufacturer for mass or rigidity.

5. Forms shall include minimum concrete reinforcing consisting of 1/2-inch bars welded in place on six-inch centers running both ways in layer 1.5 inches above bottom.
6. Provide forms with steel templates to hold anchor bolts sleeves and anchors while concrete is poured.
7. Provide height-saving brackets on all mounting locations to maintain a two-inch minimum clearance below base.
8. Flush-profile wooden formed bases having correct depth and reinforcing requirements are acceptable.
9. Product and Manufacturer: Provide one of the following:
 - a. MPF, manufactured by Vibration Mountings and Controls.
 - b. BMK, manufactured by Mason Industries.
 - c. Or approved equal.

D. Type B-3: Seismic Isolation Curb

1. Curb-mounted rooftop Components shall be mounted on structural seismic spring isolation curbs. Upper frame shall provide continuous support for Component and be captive to resiliently resist Lateral Forces. Lower frame shall accept point support for both seismic attachment and leveling. Upper frame shall provide positive fastening provisions (welding or bolting) to anchor roof top unit to curb. Sheet metal screws are unacceptable. Contact points between roof top unit, curb, and building's structure shall allow load path through those locations only.
2. All-directional neoprene snubber bushings shall be a minimum of 1/4-inch thick. Steel springs shall be laterally stable and rest on 1/4-inch thick neoprene acoustical pads.
3. Curbs' waterproofing shall meet NRCA standards.
4. All spring locations shall have access ports with removable waterproof covers and all isolators shall be adjustable, removable, and interchangeable.
5. Curb shall be sound-attenuating type utilizing standard two-inch roof insulation supplied and installed by CONTRACTOR to act thermally outside and acoustically inside. Curbs supplied without this feature shall be acoustically lined in the factory with two-inch duct liner.
6. Product and Manufacturer: Provide one of the following:
 - a. Models P6200 or P6300. Type RPFMA/SRPFMA where Option No. 1 or Option No. 2 is specified, manufactured by Vibration Mountings and Controls.
 - b. RCS, manufactured by Mason Industries.
 - c. Or approved equal.

E. Type B-4: Seismic Non-Isolated Curbs

1. Curbs shall conform to Type B-3 curbs except spring isolation is not required.
2. Product and Manufacturer: Provide one of the following:
 - a. Model P6000. Type RPFMA/SRPFMA where Option No. 1 or Option No. 2 is specified, manufactured by Vibration Mountings and Controls.
 - b. RRC, manufactured by Mason Industries.

c. Or approved equal.

F. Type B-5: Isolated Component Supports

1. Continuous structural Component support rails that combine Component support and isolation mounting into one utilized roof flashed assembly with same features specified for Type B-3.
2. System shall provide for positive anchorage or welding of Component to supports and welding of supports to building steel.
3. Product and Manufacturer: Provide one of the following:
 - a. R7200/R7300, manufactured by Vibration Mountings and Controls.
 - b. RSR, manufactured by Mason Industries.
 - c. Or approved equal.

G. Type B-6: Non-Isolated Component Supports

1. Shall be as specified for Type B-5, except without spring isolation.
2. Product and Manufacturer: Provide one of the following:
 - a. R7000, manufactured by Vibration Mountings and Controls.
 - b. RRC, manufactured by Mason Industries.
 - c. Or approved equal.

H. Type B-7: Control/Electric Room Air Conditioning Unit Base

1. Components shall be welded or bolted to welded structural steel stands having minimum 0.5 “G” certified lateral acceleration capabilities.
2. Non-Isolated stand shall have one inch adjustment capability to accommodate floor irregularities.
3. Bolting or welding required to meet seismic criteria.
4. Product and Manufacturer: Provide one of the following:
 - a. CRC, manufactured by Vibration Mountings and Controls.
 - b. CRMSL, manufactured by Mason Industries.
 - c. Or approved equal.

2.6 FLEXIBLE CONNECTORS

A. Type FC-2: Flexible Stainless Steel Hose

1. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes three-inch diameter and larger shall be flanged. Smaller sizes shall have male nipples.
2. Connector shall be braided bronze for refrigerant connections.
 - a. Minimum lengths shall be as tabulated:

Flanged: diameter x length (inches)		Male Nipples: diameter x length (inches)	
3 x 14	10 x 26	0.5 x 9	1.5 x 13
4 x 15	12 x 28	0.75 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2.5 x 18
6 x 20	16 x 32	1.25 x 12	
8 x 22			

3. Provide hoses on Component side of shut-off valves horizontally and parallel to Component shafts, where possible.
4. Product and Manufacturer: Provide one of the following:
 - a. BS, manufactured by Vibration Mountings and Controls.
 - b. BSS, manufactured by Mason Industries.
 - c. Or approved equal.

2.7 MATERIALS OF CONSTRUCTION AND FINISHES

- A. Controls including all miscellaneous structural steel and appurtenances shall be constructed of Type 316 stainless steel when located in corrosive areas, and steel when located in non-corrosive areas. These areas are listed in the corrosive and non-corrosive area designation table on the Drawings. When corrosive and non-corrosive area designation table is not included, materials of construction shall be Type 316 stainless steel unless otherwise specified in the Contract Documents.
- B. Controls shall be factory-painted per Section 09 91 00, Painting.
- C. Miscellaneous steel angles, supports, and appurtenances shall be cleaned and prime-coated in the shop and field-painted per Section 09 91 00, Painting.
- D. Hardware in corrosive areas shall be Type 316 stainless steel. Hardware in non-corrosive areas shall be galvanized steel.
- E. Neoprene and elastomer parts shall be resistant to ultraviolet radiation and constructed from high grade materials suitable for exposure to high concentrations of hydrogen sulfides, mercaptans, chlorine, and moisture in air.

2.8 IDENTIFICATION

- A. Provide each Control device with Type 316 stainless steel tag embossed or engraved with serial number cross-referenced to Component schedule, in accordance with Section 10 14 00, Signage.

2.9 ANCHORAGE

- A. Anchorages shall be per Section 05 05 33, Anchor Systems.

2.10 MISCELLANEOUS METAL

- A. Miscellaneous metal fabrications shall be per Section 05 50 13, Miscellaneous Metal Fabrications.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which Control Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Coordinate anchorage of Components to receive Controls with installation locations. Examine roughing-in of reinforcing and cast-in-place anchor bolts to verify locations before installation.

3.2 COMPONENT INSTALLATION

- A. Install Controls in accordance with Supplier's written instructions and Shop Drawings and submittals accepted by ENGINEER.
- B. Rigid connections between Components and building structure shall not be made in a manner that degrades performance of Control systems.
- C. Do not rigidly connect Isolated Components to building structure.
- D. Bracing may occur from flanges of structural beams, upper truss chords in bar joist construction, and concrete inserts or cast-in-place anchor bolts. Component support shall not overstress the structure.
- E. Install cable restraints with minimum slack to avoid short-circuiting associated Component.

- F. Install cable assemblies without slack on Non-Isolated systems. Solid braces may be used in place of cables on rigidly attached systems except where single arm braces incorporate resilient bushings.
- G. At locations where restraints or solid braces are located, brace support rods as required to accept compressive loads.
- H. Minimum operating clearance under all Isolated Component bases shall be two inches.

3.3 FIELD QUALITY CONTROL

- A. Controls Design Engineer Services:
 - 1. Controls Design Engineer shall check Controls installation before Controls and related equipment are placed into operation.
 - 2. Controls Design Engineer shall make at least one visit to the Site.
 - 3. After Controls installation is complete, Controls Design Engineer shall inspect completed Controls Work and certify in writing to CONTRACTOR that all systems are installed in accordance with design. CONTRACTOR shall submit Control Design Engineer's report to ENGINEER, certifying correctness of the Work.
- B. Supplier's Services:
 - 1. Supplier shall check Controls installation before Controls and related equipment are placed into operation.
 - 2. Supplier shall make at least one visit to the Site.
 - 3. After installation of Controls is complete, Supplier shall inspect completed Controls Work and certify in writing to CONTRACTOR that Controls are installed in accordance with Supplier's recommendations and Shop Drawings and submittals accepted by ENGINEER. CONTRACTOR shall submit Supplier's report to ENGINEER certifying correctness of the Work

3.4 ADJUSTING

- A. After entire system is started and under full operating load, adjust Controls so that Controls operate as designed.

3.5 CLEANING

- A. Remove debris from beneath Components and in and around the vibration isolator.

3.6 SUPPLEMENTS

- A. Supplements listed below, following the "End of Section" designation, are a part of this Section:
 - 1. Controls Schedules:
 - a. Schedule of Process Mechanical Components for Vibration Control.

- b. Schedule of Process Mechanical Components for Seismic Control.
 - c. Schedule of HVAC Components for Vibration Control.
 - d. Schedule of HVAC Components for Seismic Control.
 - e. Schedule of Plumbing Components for Vibration Control.
 - f. Schedule of Plumbing and Fire Protection Components for Seismic Control.
 - g. Schedule of Electrical Components for Vibration Control.
 - h. Schedule of Electrical Components for Seismic Control.
 - i. Schedule of Instrumentation Components for Vibration Control.
 - j. Schedule of Instrumentation Components for Seismic Control.
 - k. Schedule of Architectural Components for Vibration Control.
 - l. Schedule of Architectural Components for Seismic Control.
2. Controls Tables:
- a. Table 40 05 96-A - HVAC Components.
 - b. Table 40 05 96-B - Plumbing Components.
 - c. Table 40 05 96-C - Electrical Components.
 - d. Table 40 05 96-D - Process Mechanical Components.
 - e. Table 40 05 96-E - Seismic Bracing.
 - f. Table 40 05 96-F - Minimum Deflection Guide.
3. Attachment 40 05 96-A – Professional Design Services Performance Certification

++ END OF SECTION ++
CONTROLS SCHEDULES FOR SECTION 40 05 96

Section 40 05 96		
Schedule of Process Mechanical Components for Vibration Control		
Item No.	Component	Notes
1		
2		
3		
4		
5		
6		
7		

8		
9		
10		

NOTES:

1.

Section 40 05 96 Schedule of Process Mechanical Systems for Seismic Control				
Item No.	Systems	I_p	Certificate of Compliance Required	Notes
1	Seismic Controls are not required.			
2				
3				
4				
5				
6				
7				
8				
9				
10				

NOTES:

1.

Section 40 05 96 Schedule of HVAC Components for Vibration Control		
Item No.	Component	Notes
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

NOTES:

1.

Section 40 05 96**Schedule of HVAC Systems for Seismic Control**

Item No.	Component	I_p	Certificate of Compliance Required	Notes
1	Seismic Controls are not required.			
2				
3				
4				
5				
6				
7				
8				
9				
10				

NOTES:

1.

Section 40 05 96**Schedule of Plumbing Components for Vibration Control**

Item No.	Component	Notes
1		
2		
3		
4		
5		
6		

7		
8		
9		
10		

NOTES:

1.

Section 40 05 96 Schedule of Plumbing Components for Seismic Control				
Item No.	Component	I _p	Certificate of Compliance Required	Notes
1	Seismic Controls are not required.			
2				
3				
4				
5				
6				
7				
8				
9				
10				

NOTES:

1.

Section 40 05 96		
Schedule of Electrical Components for Vibration Control		
Item No.	Component	Notes
1	Vibration Controls are not required.	
2		
3		
4		
5		
6		
7		
8		
9		
10		

NOTES:

1.

Section 40 05 96 Schedule of Electrical Systems for Seismic Control				
Item No.	Component	I _p	Certificate of Compliance Required	Notes
1	Seismic Controls are not required.			
2				
3				
4				
5				
6				
7				
8				
9				
10				

NOTES:

1.

Section 40 05 96		
Schedule of Instrumentation Components for Vibration Control		
Item No.	Component	Notes
1	Vibration Controls are not required.	
2		
3		
4		
5		
6		
7		
8		
9		
10		

NOTES:

1.

Section 40 05 96 Schedule of Instrumentation Systems for Seismic Control				
Item No.	Component	I _p	Certificate of Compliance Required	Notes
1	Seismic Controls are not required.			
2				
3				
4				
5				
6				
7				
8				
9				
10				

NOTES:

1.

Section 40 05 96		
Schedule of Architectural Components for Vibration Control		
Item No.	Component	Notes
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

NOTES:

1.

Section 40 05 96 Schedule of Architectural Systems for Seismic Control				
Item No.	Component	I _p	Certificate of Compliance Required	Notes
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

NOTES:

1.

SECTION 40 05 96 TABLES

Abbreviations for Tables 40 05 96-A, 40 05 96-B, 40 05 96-C, and 40 05 96-D:

ISOL	Vibration Isolator
DEFL	Deflection
RESTR	Seismic Restraint
MTNG	Mounting
MDG	Minimum Deflection Guide – Table 40 05 96-F

General Notes (G) for Tables 40 05 96-A, 40 05 96-B, 40 05 96-C, and 40 05 96-D:

- Note G1: For variable speed Components with an operating speed below 600 RPM, select isolation deflection from Table 40 05 96-F, Minimum Deflection Guide.
- Note G2: Determine static deflection based on Table 40 05 96-F, Minimum Deflection Guide.
- Note G3: Deflections indicated are minimum at actual load and shall be selected for Supplier's nominal 5-, 4-, 3-, 2- and 1-inch deflection spring series; RPM is defined as lowest operating speed of Component.
- Note G4: Single stroke compressors may require inertia bases with thickness greater than 14-inch maximum specified for Base B-2. Inertia base mass shall be sufficient to maintain double amplitude for 1/8-inch.
- Note G4: For floor-mounted fans, substitute base Type B-2 for Class 2 or 3 and fan having static pressure over five inches of water column.
- Note G5: Indoor utility sets with wheel diameters less than 24 inches need not have deflections greater than 0.75 inches.
- Note G6: For Components with multiple motors, horsepower classification applies to largest single motor.

Reference Notes (R) for Tables 40 05 96-A, 40 05 96-B, 40 05 96-C, and 40 05 96-D:

- Note R1: For roof applications, use base Type B-5.
- Note R2: Curb Type B-3 shall use sound barrier RPFMA when there is no concrete underneath rooftop units. Curbs can be used for return plenums. (See Option No. 1 under Type B-3 base in Article 2.5 of this Section.)
- Note R3: Where curbs require supply and return sound attenuation package, use Type SRRFMA. (See Option No. 2 under Type B-3 base in Article 2.5 of this Section.)
- Note R4: Units may not be capable of point support. Refer to separate Specification Section for Component. If base is not specified in that Section and external isolation is required, provide Type B-1 base under this Section for entire unit.
- Note R5: Use Type B-6 where Non-Isolated seismic support is required.
- Note R6: Use Type B-4 where Non-Isolated seismic curbs are used.

TABLE 40 05 96-A - HVAC COMPONENTS										
COMPONENT	HP, CLASS, OR SIZE	MTNG	Mounted on Soil Supported Slab				Mounted on Suspended Slab and Floor or Roof System			
			ISOL	DEFL (in.)	BASE	RESTR	ISOL	DEFL (in.)	BASE	RESTR
Absorption Machine		Flr.	---	---	---	IV	B	0.75	B-2	IV
Air Handling Units Indoor		Flr	B	0.75	---	IV	B	See MDG	---	IV
		Clg	E	0.75	---	V	E	See MDG	---	V
Air Compressor Tanks	To 10 HP	Flr	B	0.75	---	IV	B	0.75	---	IV
	>10 HP	Flr	B	0.75	B-2	IV	B	1.50	B-2	IV
Dry Coolers Condensers/Condensing Outdoor Units		Roof	---	---	---	IV	B	2.50 (minimum)	B-5	IV
Axial Fans (Inline Type)		Flr	B	0.75	---	IV	B	See MDG	---	IV
		Clg	E	0.75	---	V	E	See MDG	---	V
Base Mounted Pumps	To 15 HP	Flr	B	0.75	B-2	IV	B	0.75	B-2	IV
	>15 HP	Flr	B	0.75	B-2	IV	B	1.50	B-2	IV
Boilers		Flr	G	0.10	---	IV	B	0.75	---	IV
Cabinet Fans & Packaged AHU Indoor	To 1 HP	Flr	F	0.20	---	IV	B	0.75	---	IV
		Clg	D	0.35	---	V	E	0.75	---	V
	>1 HP	Flr	B	0.75	---	IV	B	See MDG	---	IV
		Clg	E	0.75	---	V	E	See MDG	---	V
Centrif. Chillers		Flr	B	0.75	---	IV	B	1.50	---	IV
Centrif. Fans Arr. 1 & 3	Class 1	Flr	B	0.75	B-1	IV	B	See MDG	B-1	IV
	Class 2 & 3	Flr	B	0.75	B-2	IV	B	See MDG	B-2	IV
Centrif. Fans (Vent Sets) Arr. 9 & 10	Class 1	Flr	B	0.75	---	IV	B	See MDG	See Note R1	IV
	Class 2 & 3	Clg	E	0.75	B-2	V	E	See MDG	B-2	V
Computer Room Units		Flr	F	0.20	B-7	IV	B	1.5	B-7	IV
Condensate Pumps		Flr	F	0.20	If req.	IV	F	0.20	If req.	IV
Cooling Towers		Flr	B	0.75	---	IV	B	2.50	B-5 opt.	IV
Curb Mtd. Equip. (Non-Isol.)		Roof	---	---	---	IV	---	---	B-6	IV
Fan Coil Units		Flr	F	0.20	---	IV	B	0.75	---	IV
		Clg	D	0.35	---	V	E	0.75	---	V
Outdoor Reciprocating, Rotary or Screw Chillers		Flr	F	0.20	---	IV	B	1.50	---	IV
		Roof	---	---	---	IV	B	2.50	B-5 See note R5	IV

TABLE 40 05 96-A - HVAC COMPONENTS (Continued)										
COMPONENT	HP, CLASS, OR SIZE	MTNG	Mounted on Soil Supported Slab				Mounted on Suspended Slab and Floor or Roof System			
			ISOL	DEFL (in.)	BASE	RESTR	ISOL	DEFL (in.)	BASE	RESTR
Rooftop AHU/AC	< 10 Ton	Roof	---	---	---	IV	B	1.50	B-3 see notes R2, R3, R6	IV
	> 10 Ton	Roof	---	---	---	IV	B	2.50	B-3 see notes R2, R3,R6	IV
Unit/Cab Heaters		Clg	D	0.30	---	V	D	0.30	---	V

TABLE 40 05 96-B - PLUMBING COMPONENTS										
COMPONENT	HP	MTNG	Mounted on Soil Supported Slab				Mounted on Suspended Slab and Floor or Roof System			
			ISOL	DEFL (in.)	BASE	RESTR	ISOL	DEFL (in.)	BASE	RESTR
Air Compressors & Vacuum Pumps	to 10	Flr	B	0.75	---	IV	B	0.75	---	IV
	>10	Flr	B	0.75	B-2	V	B	1.50	B-2	IV
Base Mounted Pumps	to 15	Flr	B	0.75	B-2	IV	B	0.75	B-2	IV
	>15	Flr	B	0.75	B-2	IV	B	1.50	B-2	IV

TABLE 40 05 96-C - ELECTRICAL COMPONENTS

			ON GRADE				ABOVE GRADE			
COMPONENT	SIZE	MTNG	ISOL	DEFL	BASE	RESTR	ISOL	DEFL	BASE	RESTR
Transformer Dry type	All	Flr	--	--	--	IV	D	0.30	See note R4	IV
		Ceiling	--	--	--	V	E	0.20	See note R4	V
Generators	All	Flr	B	1.0	--	IV	B	1.50	See note R4	IV
Generators	All	Over Occupied Space					B	2.50	See note R4	IV
UPS Systems	M		II	0.40		IV	B	1.50	See note R4	IV

TABLE 40 05 96-D - PROCESS MECHANICAL COMPONENTS										
COMPONENT (See Notes)		MTNG	On Grade, Basement, or Slab on Grade				Above Grade			
			ISOL	DEFL (in.)	BASE	RESTR	ISOL	DEFL (in.)	BASE	RESTR

TABLE 40 05 96-E – SEISMIC BRACING (Max. Brace Spacing Shown – Actual Spacing to be Determined by Calculation)*			
COMPONENT	ON CENTER TRANSVERSE (Spacing in Feet)	ON CENTER LONGITUDINAL (Spacing in Feet)	CHANGE OF DIRECTION (Distance in Feet)
HVAC Duct	30	60	4
PIPE – NO HUB OR BELL AND SPIGOT			
2.5-inch dia. and larger	10	20	4
PIPE – ALL OTHER JOINT TYPES			
16-inch dia. and smaller	40	80	4
18 to 28-inch dia.	30	60	4
30 to 40-inch dia.	20	60	4
42-inch dia. and larger	10	30	4
MISCELLANEOUS			
Breeching	30	60	4
Chimneys and Stacks	30	60	4
Electrical Conduit	40	80	4
Electrical Bus Duct	20	40	4
Cable Tray	40	80	4

* Note: See Paragraph 2.1.C.11.b of this Section regarding fuel oil, natural gas piping, thermoplastic piping, and glass-lined pipe.

**Table 40 05 96-F – MINIMUM
DEFLECTION GUIDE**

RPM	MINIMUM REQUIRED DEFLECTION (inches)
Less than 400	3.5
401 to 600	2.5
601 to 900	1.5
Over 900	0.75

ATTACHMENT 40 05 96-A
Professional Design Services Performance Certification
(Page 1 of 2)

NTS: INSERT AT NO. 1 THE STATE OF THE SITE.

1. My name is _____.
2. My Connecticut professional engineering/architecture license number is
_____.
3. My license expires _____, 20_____.
4. The Project for which I have performed professional design services is described as
_____.
5. The Specification Section(s) under which I have performed my services is/are
_____.
6. The name and address of the individual or entity for whom I have performed
professional design services is:

ATTACHMENT 40 05 96-A
Professional Design Services Performance Certification
(Page 2 of 2)

7. I hereby certify that, to the best of my knowledge, information, and belief, I have performed or supervised performance of the professional design services hereunder, and that said services have been performed in accordance with Laws and Regulations and in accordance with the standard of care currently expected of professional engineers/architects performing similar services for Projects of similar size and complexity in (--1--).

Date

Signature

Type or Print Name

Name of Firm

Street Address

[PROFESSIONAL SEAL]

City/State/Zip Code

Telephone: _____

Fax: _____

SECTION 40 60 05

INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a complete and operating instrumentation and control system.
 2. The Work includes, but is not limited to, the following:
 - a. Main Control Panel (MCP) and panel mounted instruments.
 - b. Level Monitoring Panel and panel mounted instruments.
 - c. Programmable logic controllers (PLC) and software.
 - d. Operator Interface Terminals (OIT).
 - e. Uninterruptible power supply.
 - f. Interfaces of field instruments to the MCP via hardwired signals, and Modbus RS-485 as specified in the P&IDs.
 - g. Field mounted instruments.
- B. CONTRACTOR shall assign Input/Output (I/O) tags using the I/O numbering convention specified at the end of this Section and as shown in the contract drawings.
- C. In order to centralize responsibility, it is required that all equipment provided under this Section be furnished by a single system Supplier as specified in Article 1.3, below. CONTRACTOR shall guarantee and be the source of information on all equipment, materials, and appurtenances furnished regardless of the manufacturing and supply source of the equipment.
- D. Related Sections:
1. Division 26, Electrical.
 2. Division 40, Process Mechanical.
 3. Division 46, Equipment.

1.2 REFERENCES

- A. The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature, define parameters of configuration and construction, in addition to specific details in this Specification and the Contract Drawings:
1. ISA, Instrument Society of America.
 2. API, American Petroleum Institute.
 3. UL, Underwriters' Laboratories, Inc.

4. AWWA, American Water Works Association.
5. NRC, Nuclear Regulatory Commission.
6. NEMA, National Electrical Manufacturers Association.
7. OSHA, Occupational Safety and Health Administration.
8. ANSI, American National Standards Institute.
9. MIL, Military Standards.
10. NFPA, National Fire Protection Association.
11. SAMA, Scientific Apparatus Manufacturers Association.
12. JIC, Joint Industrial Council.
13. IEEE, Institute of Electrical and Electronic Engineers.
14. NEC, National Electrical Code.
15. FM, Factory Mutual.

1.3 QUALITY ASSURANCE

A. General:

1. All equipment, components and materials required shall be furnished by a single System Supplier who shall assume the responsibility for adequacy and performance of all items.
2. The System Supplier shall identify those system components which are not of his manufacture.
3. The System Supplier shall supply his company's Quality Assurance Plan (QA), and for components which are not of his manufacture, the component manufacturer's Quality Assurance Plan. QA plans shall state, but not be limited to, methods of testing, raw material criteria, methods of documentation, station control, "Burn-In", final tests, and serialization coding, packaging; application of MIL 883B, HDBK-217D relevant sections, to be documented as a submittal. If any of the above operations are not 100 percent, then the manufacturer is to supply his company Quality Assurance Sampling Plan. Said plan shall be in accordance with the requirements of MIL-105D.

B. System Supplier's Qualifications:

1. Shall be a financially sound firm having at least five years continuous experience in designing, implementing, supplying and supporting instrumentation and control systems for wastewater treatment facilities which are comparable to the Project in terms of hardware, software, cost and complexity.
2. Shall have a demonstrated experience record of successful instrumentation and control system equipment installations.
3. Shall have in existence at the time of bid advertisement, an experienced engineering and technical staff capable of designing, supplying, implementing and supporting the instrument and control system and handling the submittal and training requirements.
4. Shall be capable of providing training for OWNER'S personnel in instrumentation and process control applications and in operation, programming and maintenance of the control system and equipment.
5. Shall have a record of prompt shipments in accordance with Contract obligations required for previous projects.

6. Shall have a demonstrated record of prompt positive response to system failures at the field.
 7. Shall maintain a fully qualified service facility within a radius of 60 miles of the Site. During period of the warranty, the System Supplier shall guarantee timely response to all service calls (on-Site within 24 hours to correct all critical failures, within 72 hours to correct all non-critical failures and problems). Incurred expense for this service, inclusive of the cost of all materials and replacement parts, shall be born by CONTRACTOR.
 8. Shall have a UL approved panel shop.
- C. Manufacturer's Qualifications: The manufacturers of instrumentation and control equipment provided under this Section and other equipment Sections shall have experience in producing similar equipment, shall show evidence of installations in satisfactory operation, and shall meet the following qualifications:
1. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
 2. Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
 3. Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
 4. Shall have documented product safety policy relevant to products proposed for the Work.
- D. System Supplier's Responsibilities:
1. CONTRACTOR shall retain the System Supplier to assume the responsibilities specified below. However, execution of these specified duties by the system Supplier shall not relieve CONTRACTOR of the ultimate responsibility for providing a fully functional instrumentation and control system equipment that meets all the requirements specified.
 - a. Preparation, assembly and correction of all instrumentation and control equipment submittals in accordance with the Contract Documents and procedures.
 - b. Proper interfacing of the instrumentation and control equipment with field equipment, instruments, devices and panels, including required interfacing with package control systems furnished by other equipment Suppliers and with the plant electrical system.
 - c. Review, approval and coordination with manufacturers, System Suppliers and other contracts of Shop Drawings for equipment, valves, and piping for the purpose of ensuring proper interface of hardware, locations and installation of in-line instruments and instrument taps.
 - d. Direct, detailed supervision of the installation of the instruments, panels, consoles, cabinets, wiring and other components as well as related wiring and piping connections.
 - e. Calibration, testing (Factory and Field) and start-up of the system.
 - f. Handling of all warranty obligations for the instrumentation and control system components.

- g. Training of OWNER'S personnel in operation and maintenance (including calibration and troubleshooting) of the instrumentation and control equipment.
- E. Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter's Laboratories (UL), Inc., and so marked or labeled, together with Manufacturer's brand or trademark.

1.4 SUBMITTALS

A. System Supplier Approval:

1. General:

- a. System Supplier qualifications shall be submitted with Bidder's submittal.
- b. Qualification submitted shall show, explicitly, that the System Supplier has the organization and facilities to comply with Paragraph 1.3.B., above.
- c. The detailed presentation of the proposed System Supplier's qualifications shall conform to Paragraph 1.3.B., above.

B. Action Submittals: Submit the following:

1. **Submittal No. 1** – Field Instruments Submittal:

- a. Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
- b. Instrument tag number in accordance with the Contract Documents.
- c. Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
- d. Description of construction features.
- e. Performance and operation data.
- f. Installation, mounting, and calibration details; instructions and recommendations. For submittal no.1 these can be generic details as provided by the manufacturer.
- g. Service requirements.
- h. Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
- i. Range of each device and calibration information
- j. Descriptions of materials of construction and listing of NEMA ratings for equipment

2. **Submittal No. 2** – Panel and cabinet product information, layouts and wiring schematics

- a. Panel component product information:
 - 1) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
 - 2) Description of construction features.
 - 3) Performance and operation data.
 - 4) Installation, mounting, and calibration details; instructions and

- recommendations.
- 5) Service requirements
- b. Layout drawings:
 - 1) Front, rear, and internal panel or network cabinet views to scale.
 - 2) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.
 - 3) Product information on panel components.
 - 4) Nameplate location and legend including text, letter size and colors to be used.
 - 5) Location of anchorage connections.
 - 6) Location of external wiring and piping connections.
 - 7) Mounting and installation details, coordinated with actual application.
 - 8) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.
 - 9) Calculations substantiating panel heating and cooling provisions proposed.
 - 10) Subpanel layouts and mounting details for items located inside control panels.
 - 11) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.
- c. Panel wiring diagrams:
 - 1) Name of each panel, console, or cabinet.
 - 2) Wire sizes and types.
 - 3) Pipe sizes and types.
 - 4) Terminal strip and terminal numbers.
 - 5) Wire color coding.
 - 6) Functional name and manufacturer's designation for components to which wiring and piping are connected.
 - 7) Lightning and surge protection grounding.
 - 8) Electrical control schematics shall be in accordance with NFPA 79. Control schematics shall be in accordance with convention indicated in Annex D of NFPA 79. Standardized wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.
- 3. **Submittal No. 3** – PLC/OIT System and Network Documentation and Configuration.
 - a. Submit the following general information:
 - 1) Detailed network and block diagrams using drawing I-13 as a basis, but expanded across multiple pages to show system hardware configuration, identification of model numbers of all system components, and complete network component BOM.
 - 2) Software listings and allocation table for all software provided, including PLC, OIT, special packages, add-ons, drivers and operating system, software language and organization to be used.
 - 3) PLC connectivity details including proposed initial settings for

- all PLC and/or networks.
 - 4) Network and Ethernet switch configuration details.
 - 5) IP allocation and listing table, including vendor panels.
- 4. **Submittal No. 4** – Comprehensive Project I/O Tag Database.
 - a. Tag database listing, including all hardwired I/O points and I/O points communicated over digital networks. This should clearly identify all points from vendor or Supplier control systems. Coordinate with each vendor prior to submitting this list. Identify all spares (hardware and software) on the list.
 - b. Coordinate with each packaged vendor to include tag databases for each.
 - c. List or mark all points to be: (a) trended, (b) historically archived.
 - d. Approval of the tag database does not relieve systems integrator of resolving all coordination issues with vendor panels in the field, including addition, deletion, or modification of points.
 - e. Submittal No.4 shall not be approved until Submittal No.5 is completed.
- 5. **Submittal No. 5** – Control Strategy and OIT Platform information:
 - a. Submit detailed control narratives. Control narratives shall be subject to modification from CONTRACTOR's submitted within limits of the Contract Documents.
 - b. Submit platform information for the OIT. Each graphic display will be subject to modification from CONTRACTOR's submitted format within limits of software package used for development.
 - c. Expect at minimum 3 revisions of this submittal with comments from the ENGINEER: (1) preliminary, (2) draft, (3) final for approval. Implement such modifications in accordance with ENGINEER's written comments on the submittal.
 - 1) The preliminary submittal shall include the following at minimum:
 - a) Sample of all standard symbols, displays and blocks to be used on the project.
 - b) Sample of proposed color schemes.
 - c) Sample OIT screen as a template for screen layout.
 - d) Complete list of proposed OIT screens. Include screen name and brief description on contents.
 - e) Proposed OIT screen navigation hierarchy.
 - f) Draft control narratives.
 - g) PLC interfacing detailed, licensing structure, and included functions for control and failure modes, online and offline capabilities for programming, system utilities, and diagnostics.
 - h) OIT interfacing details, licensing structure, and included functions.
 - i) Format and configuration of log reports, alarm summaries, printer outputs, displays, and graphics.
- 6. **Submittal No. 6** – Loop wiring diagrams:
 - a. Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and

- power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
- b. Wiring types, wire numbers, and color coding.
- c. Designation of conduits in which field I/O wiring will be installed.
- d. Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
- e. Prepare loop wiring diagrams in accordance with ISA 5.4.
- 7. **Submittal No. 7** - Factory Acceptance Test Procedure: Submit proposed procedures for factory testing required to comply with the Contract Documents. Test procedure shall include the following at minimum:
 - a. Visual inspection of components and assembly.
 - b. Description of point by point and device by device hardware operational testing.
 - c. Description of line by line software demonstration testing.
 - d. Description of testing equipment and methods to be used. Identification of simulations to be performed to test software functions.
 - e. Sign-off sheets to be used at time of testing.
 - f. FAT shall not be scheduled without approved Submittal No. 1 through 5.
- 8. **Submittal No. 8** – Field mounting Details.
- 9. **Submittal No. 9** – Checkout, Start-up, and Field Testing Procedure: Submit proposed procedures for checkout, start-up and field testing required to comply with the Contract Documents. Procedure shall include the following at minimum:
 - a. Schedule for start-up and testing procedures.
 - b. Description of start-up procedure for each system.
 - c. Description of network test and diagnostic procedures for process control network.
 - d. List of field instruments, devices, and loops requiring calibration reports
 - e. Sign-off sheets to be used at time of testing.
- C. Informational Submittals: Submit the following:
 - 1. Documents to be submitted prior to pre-submittal conference, in accordance with this specification.
 - 2. System Software Documentation: Submit preliminary software documentation not later than four (4) weeks prior to scheduled start of factory testing. Software documentation shall include the following:
 - a. Complete printed copy of all PLC programming (hard copy printed from .PDF electronic format shall be acceptable).
 - b. Complete printed copy listing of external and internal I/O address assignments, register assignments and preset constant values with function point descriptions. List unused/undefined I/O and data table registers available.
 - c. Complete printed copy of all configured OIT screens. Runtime screens and developer screens layouts shall be provided to show location of animated graphics based on visibility.
 - d. Color electronic .PDF versions of the above.

3. Manufacturer's Instructions:
 - a. Shipping, handling, storage, installation, and start-up instructions.
 - b. Templates for anchorage devices for materials and equipment that will be anchored to concrete or masonry.
 4. Source Quality Control Submittals:
 - a. Results of factory testing.
 5. Special Procedure Submittals:
 - a. Notification to OWNER and ENGINEER at least fourteen (14) days before readiness to begin system checkout at the Site. Schedule system checkout on dates acceptable to OWNER and ENGINEER.
 - b. Written procedure for system checkout. Submit not less than ninety (90) days prior to starting system checkout.
 - c. Ninety (90) days prior to starting system checkout submit written procedure for start-up.
 6. Field Quality Control Submittals:
 - a. Submit the following prior to commencing system checkout and start-up.
 - 1) Completed calibration sheets for each installed instrument showing five-point calibration (zero, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
 - b. Field calibration reports
 - c. Field testing result reports.
 7. Supplier's Reports:
 - a. Installation inspection and check-out report.
 - b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- D. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 01 78 23, Operation and Maintenance Data.
 - b. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.
 2. Record Documentation:
 - a. Prepare and submit record documents in accordance with Section 01 78 39, Project Record Documents.
 - b. Revise all PCS Shop Drawings to reflect as-built conditions in accordance with the following.
 - 1) Use "as-built" updates of approved Shop Drawings and submittals in operation and maintenance manuals.
 - 2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes inside a suitable print pocket or container inside each control panel.
 - 3) Place a copy of "As-Built" network diagram(s) in each control panel in a clear plastic envelope.

- 4) Submit drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.
- E. Maintenance Materials Submittals: Submit the following:
1. Spare Parts and Test Equipment:
 - a. General:
 - 1) Furnish the spare parts and test equipment in accordance with the Contract Documents, identical to and interchangeable with similar materials and equipment provided for the PCS under the Contract.
 - 2) Provide source quality control for spare parts as part of factory testing prior to shipment of process control system equipment.
 - b. Furnish the following spare parts:
 - 1) Five of each type of input/output relay for each quantity of forty or fraction thereof provided under the Contract.
 - 2) One of each type of PLC input/output module or card used.
 - 3) One of each type of PLC processor.
 - 4) One of each type of PLC redundant module.
 - 5) One of each type of PLC communication module.
 - 6) One of each type of PLC power supply.
 - 7) One replacement power supply for each type and size provided under the Contract.
 - 8) One-year supply of all expendable or consumable materials.
 - 9) One per quantity of five or fraction thereof of gauges, indicators, and switches provided, complete with diaphragm seals, filled and ready to use.
 - 10) One per quantity of ten or fraction thereof provided, per range of field instruments including insertion type or strap-on instruments. No spares are required for inline instruments such as magnetic flow meters and flumes or venturis that include flow tubes through which flow is conveyed.
 - 11) Twelve of each type and size of fuse used in instruments.
 - c. Furnish the following test equipment:
 - 1) One Fluke, Hewlett-Packard, or equal (latest in series) digital multimeter plus amprobe, signal simulators (four to 20 mA DC; one to five VDC), test leads, case, and other recommended spares and accessories.
 - 2) Tooling required to insert, extract, and connect internal or external connectors, including edge connectors.
 - 3) Special calibration equipment required for system calibration.
 2. Software:
 - a. Provide electronic copies of native file and color .PDF format to the OWNER on CD for all final configurations provided on the project.
 - b. Submit copies in native file and color .PDF format of programming and configuration files developed specifically for the Project in accordance with Section 01 78 23, Operations and Maintenance Data.

1.5 GENERAL DESIGN REQUIREMENTS

A. Power Supplies:

1. Electrically powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, single-phase, 60 Hertz plus-or-minus two Hertz, power supply. If different voltage or closer regulation is required, provide suitable regulator or transformer at no additional cost to OWNER.
2. Provide appropriate power supplies for field instruments requiring power source less than 115 volts. Power supplies shall be mounted in control panels or enclosures installed near associated instrument or in field panels.
3. Power supplies shall be capable of minimum of 130 percent of maximum simultaneous current draw.

B. Signal Requirements:

1. The control system shall be designed to use 4 to 20 mADC analog signals, unless otherwise specified.
2. Signal converters and repeaters shall be provided where required. Power supplies shall be sized adequately for signal converter and repeater loads.
3. Signals shall be isolated from ground.
4. Signals shall not have a transient DC voltage exceeding 300 volts over one millisecond nor a DC component over 300 volts.

C. Miscellaneous:

1. All instrumentation components shall be heavy-duty types, designed for continuous service. The system is to contain products of a single manufacturer, when possible, and to consist of equipment models which are currently in production. All equipment provided is to be of modular construction and be capable of field expansion through the installation of plug-in circuit cards and additional cabinets as necessary. Design all logic and control loops to fail-safe.
2. All instrumentation components shall be designed to return automatically to accurate measurement within 15 seconds upon restoration of power after a power failure or when transferred to standby power supply.
3. Surge protection shall be provided for all instruments and all other control system components which could be damaged by electrical surges. Lightning arresters shall be provided on both ends of communication lines external to the building, including leased telephone lines.
4. All field-mounted instruments and system components shall be designed for installation in humid and corrosive service conditions. All field mounted instrument enclosures, junction boxes and appurtenances shall conform to NEMA 4X requirements, unless otherwise specified.
5. All relays with interconnections to field devices shall be wired through terminal blocks. Terminals as part of the relay base are not an acceptable alternate.
6. All panel mounted instruments, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance. All front of panel mounted devices shall be of the same manufacturer and model line.

7. All components furnished, including field and rear of panel instruments, shall be tagged with the item number and nomenclature indicated in the Contract Documents and/or approved Shop Drawings.
8. Ranges and scales specified herein shall be coordinated to suit equipment actually furnished.
9. Field-mounted devices shall be treated with an anti-fungus spray.
10. Field-mounted devices shall be protected from exposure to high temperature and freezing temperatures.

D. Environmental Conditions:

1. The control system shall be designed and constructed for continuous operation under the following temperature and humidity conditions:
 - a. Indoor locations for instruments:
 - 1) Ambient Temperature: 0 F to 120°F.
 - 2) Relative Humidity: 100 percent, maximum.

1.6 FACTORY TESTING

A. General:

1. CONTRACTOR shall submit information on factory testing procedures to verify that testing shall fulfill the requirements as specified herein.
2. OWNER and ENGINEER may elect to be present at CONTRACTOR'S facilities during operational test of system equipment, either for individual units or as an integrated system. Presence of OWNER and ENGINEER during testing does not relieve CONTRACTOR from conforming to the requirements of the Contract Documents and shall in no way imply acceptance of the equipment.
3. When the factory tests have been successfully completed, a Factory Test Report shall be submitted to ENGINEER. The equipment shall not be shipped until Notice of Acceptance of the test is received by CONTRACTOR.

B. Inspection:

1. All panels, consoles and cabinets shall be inspected. Inspection shall include, but not be limited to the following:
 - a. Nameplates and tags.
 - b. Wire sizes and color coding.
 - c. Terminal block contact ratings and numbers.
 - d. Annunciator and terminal block spares.
 - e. Proper wiring practices and grounding.
 - f. Enclosure flatness, finish and color.

C. System Operational Testing:

1. All input/output devices and components shall be tested to verify operability and basic calibration.
2. All system hardware components equipment shall be tested to verify proper operation of the equipment as stand alone units. Test shall include, but not be limited to, the following:
 - a. AC/DC power checks.

- b. Power fail/restart tests.
 - c. Diagnostics checks.
 - d. Test demonstrating that all specified equipment functional capabilities are working properly.
- 3. All system components shall be tested to verify that communication between units is working properly.
- 4. An integrated system test with all system equipment and simulated inputs/outputs connected shall be performed to verify that all equipment is performing properly as an integrated system. Both types of communication (leased and dial-up) shall be tested.
- 5. A complete factory test for each panel shall be performed. All signals (both analog and digital) shall be simulated. Simulation devices shall be of suitable quality so as not to mask control panel defects. A successful test will be defined as all components within the respective control panel, being tested and certified for its intended function. The test shall be fully witnessed and certified by a Registered Professional Engineer who will sign and seal the Factory Test Reports. CONTRACTOR shall provide two weeks notice to the ENGINEER prior to the testing so that witnessing of the test may be observed. Witnessing will be at the ENGINEER'S option.

1.7 STORAGE AND HANDLING

- A. Each manufacturer or System Supplier securely attach the tag number and instructions for proper field handling and installation to each instrument prior to packaging.
- B. Each manufacturer or System Supplier package control cabinets and instrumentation to protect against shipping damage, dust, moisture, and atmospheric contaminants. Include a shipping label which contains the following information:
 - 1. Tag number, equipment number and description.
 - 2. Instructions for unloading transporting, storing and handling at the Site.
- C. Receive control cabinets and instrumentation at the Site. Inspect control cabinets and instrumentation for damage in shipment and return damaged control cabinets and instrumentation to the manufacturer.
- D. Do not store control cabinets and instrumentation out-of-doors. Provide dry, heated permanent storage facilities and pay storage costs.

PART 2 – PRODUCTS

2.1 SURGE PROTECTION DEVICES

- A. Requirements:
 - 1. General: Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power

supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Instruments shall be housed in suitable metallic cases, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate junction box (compatible with the area designation) coupled to the enclosure.

2. Provide formal lightning and surge protection devices for all signal lines, data highways, and power interfaces with PLCs at remote sites. For signal lines, data highways, power feeds to control panels and PLC hardware, provide formal lightning and surge protection devices for all lines that originate or are routed outside a building on any part of the existing or proposed circuit, on in either buried or exposed raceways. Provide formal lightning and surge protection for all transmitters installed under this Contract in an outside environment.
3. Lightning and surge protection devices shall be standard manufactured products comprising multi-component networks or hybrid circuits. The units shall incorporate gas filled discharge tubes, and zener diodes providing full protection from line to line and from line to ground.
4. Units shall be pluggable, din-rail mounted, rated for a 10KA maximum surge current and voltage suitable for the type of circuit being protected. Reaction time shall be in the order of nanoseconds. Units shall include local and remote fail indication.

B. The units shall be as manufactured by Phoenix Contact, or equal.

2.2 PROCESS TAPS, SENSING LINES, AND ACCESSORIES

- A. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters:
1. Material: Type 316 stainless steel tubing, ASTM A269, medium wall thickness.
 2. Pressure Rating: Same as connecting pipe .
 3. Size: 3/8-inch OD for air.
 4. Connections: Type 316 stainless steel compression type.
 5. Shut-off Valves:
 - a. Type: Ball.
 - b. Pressure Rating: Same as connecting pipe .
 - c. Body, Ball and Stem: Type 316 stainless steel.
 - d. Packing: High density Teflon.
 - e. Handle: Nylon with metal travel stops.
 - f. Support Rings: Teflon coated Type 316 stainless steel.
 - g. End Connections: Removable.
 - h. Products and Manufacturers: Provide one of the following:
 - 1) Whitey Valves.
 - 2) Anderson Greenwood.
 - 3) Or equal.

6. Manifolds:
 - a. Type: Five-valve and three-valve meter manifolds.
 - b. Materials: Type 316 stainless steel body, bonnets and stems; delrin seats; Teflon packing.
 - c. Products and Manufacturers: Provide products of one of the following:
 - 1) Anderson-Greenwood.
 - 2) Swagelok.
 - 3) Or equal.
- B. Pressure Tap Sensing Lines and Accessories for Pressure Gauges and Pressure Switches:
 1. For Process Sensing Taps in Ductile Iron, Steel and Stainless-Steel Piping Systems:
 - a. Material and Fittings: Type 304 stainless steel pipe, ASTM A312; and threaded fittings and adapters, ASTM A403.
 - b. Sizes: 3/4-inch diameter minimum for main sensing piping and 3/4-inch diameter gauge and switch connections.
 - c. Accessories:
 - 1) For applications not requiring diaphragm seals, provide separate 1/2-inch diameter Type 316 stainless steel threaded ball valve for each gauge and switch.
 - 2) For applications requiring diaphragm seals, provide separate 1/2-inch diameter threaded Type 316 stainless steel ball valve for seal process side shutoff.
 2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
 - a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. Provide PVC and CPVC piping in accordance with Section 40 05 31, Thermoplastic Process Pipe.
 - b. Sizes: 1/2-inch diameter minimum for main process sensing piping and 1/4-inch diameter for gauge and switch connections.
 - c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Contract Documents.
 - d. Accessories:
 - 1) For copper piping system taps with or without seals, provide separate 1/2-inch diameter minimum threaded brass or bronze ball valve for each gauge and switch.
 - 2) For PVC and CPVC piping systems with or without diaphragm seals, provide separate 1/2-inch diameter threaded ball valve for process sensing line shutoff.

2.3 PANELS

- A. General Provisions:
 1. Provide electrical components and devices, support hardware, fasteners, and interconnecting wiring and piping required to provide control panels complete and operational.
 2. Locate and provide hardware so that connections can be easily made and there is ample room for servicing each item.

3. Prevent movement by adequately supporting and restraining devices and components mounted on or within panel.
4. Provide panels with sub-panels for installation of all internally mounted hardware.
5. Provide numbered terminal strips for terminating field wiring and wiring from other panels, unless otherwise shown or indicated.
6. Provide copper grounding studs for hardware requiring grounding.
7. Provide the following convenience accessories inside each panel:
 - a. One 120 vac, 20-amp duplex, grounding type receptacle.
 - b. One 120 vac fluorescent service light fixture with 20-watt lamp and protective plastic shield or appropriate wattage incandescent bulb for panels two feet by two feet and smaller.
 - c. One 120 vac snap switch, to turn on service light, mounted in outlet box with cover and located so that switch is easily accessible from access door.
 - d. Service light with switch and duplex receptacle shall have a dedicated circuit breaker.
8. Control of Environment (Except NEMA 7 Panels):
 - a. Provide 120 vac thermostatically-controlled fan-driven heater units to maintain stable temperature within enclosure to protect equipment from harmful effects of condensation, corrosion, and low temperatures inside panels.
 - b. Provide automatically controlled closed-loop heat exchangers or closed-loop air conditioners to maintain temperature inside each enclosure at optimum operating temperature rating of components inside the enclosure.
 - c. Each heat exchanger or air conditioner shall have a dedicated, properly-sized and -rated circuit breaker.
 - d. Submit supporting calculations as part of panel Shop Drawing submittal if panel equipment to comply with specified environmental requirements is proposed to be deleted as unnecessary.
9. Panels to be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.
10. Panels to be located in hazardous (classified) environments shall comply with UL 698A and UL 2062.
11. Provide panels under this Section with 20 percent additional space requirements for future use. Install nothing in space reserved for future use.
12. CONTRACTOR is responsible for detailed layout and design of panels, in accordance with the Contract Documents. Base cutouts and design on instrument manufacturers' requirements.
13. Lower 12 inches of free standing panels shall be free of devices, including panduits and terminal strips, for ease of installation and maintenance.
14. For front-opening panels, install no device less than three feet above operating floor level, unless otherwise shown or indicated. For rear-opening panels, install no devices on the door.
15. Wire bundles between subpanels and front panel-mounted devices shall be anchored and protected from damage by opening and closing of panel door.

16. Do not locate front panel-mounted devices requiring manipulation by operating personnel, such as pushbuttons, hand switches, controllers, and similar devices, higher than 5.5 feet above finished floor.
17. Panduits located on either side of terminal strips shall have minimum clearance of 1.5 inches between panduit and terminal strip.
18. Provide three-inch high channel base assembly, drilled to mate panel to floor pad.
19. Provide easily-accessible pocket built into panel door to enclose “as built” panel wiring diagrams.
20. Panels shall be UL-listed.

B. Identification:

1. Provide laminated plastic nameplate for identification of panels. Use self-tapping stainless-steel screws for fastening nameplates to panels. When self-tapping screws may degrade panel’s NEMA rating, retain NEMA rating intact by using gaskets on each side of panel surface and use retaining plate on the panel back that is same size as nameplate. When gaskets and retaining plate are used, use full-penetration screws with nuts.
2. Panel identification nameplates shall have 1/2-inch high engraved letters.
3. Identify front panel-mounted devices with nameplates engraved with functional description of the device. Nameplate engraving shall be in accordance with the identification provided in the Drawings .
4. Tag electric components and devices mounted within panels with high adhesive labels.
5. Identify terminal strips with nameplate engraved as “TB-XX” where “XX’ is the numerical identification of terminal strip.
6. Identify terminals within each terminal strip with sequential numbers and wire numbers.
7. Internal panel wiring shall be color-coded and numerically identified with unique wire numbers affixed at each end of each wire. Color coding shall be in accordance with panel wiring color code table, below:

Panel Wiring Color Code Table

Description	Color
110 vac panel power before fuses or breakers	Black
Controlled 110 vac power (e.g., after relay contacts, selector switch contacts, and similar equipment.)	Red
110 vac power source from devices external to panel	Yellow
110 vac neutral	White
24 vdc positive power from power supplies	Brown
24 vdc negative power from power supplies	
Controlled 24 vdc power (e.g., after PLC output contacts, relay contacts, and similar)	Blue
24 vdc positive power from devices external to panel	Orange
24 vdc negative power from devices external to panel	
24 vdc four to 20 mA DC signal cable	Grey with red positive, clear negative
Grounding wire	Green

C. Panel Construction Features:

1. Panels located inside control or electric room areas shall be rated NEMA 12 with the following features:
 - a. Fabricate enclosures using minimum 14-gage steel for wall- or frame-mounted enclosures and minimum 12-gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
 - b. Continuously weld exterior seams and grind smooth. Surface grind panel to completely remove corrosion, burrs, sharp edges, and mill scale.
 - c. Reinforce sheet steel with steel angles where required to adequately support devices and equipment and ensure rigidity and to preclude resonant vibrations.
 - d. Panel shall be flat within tolerance of 1/16-inch over two-foot by two-foot area, or flat within tolerance of 1/8-inch for larger surface area. Acceptable out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
 - e. Use pan type construction for doors. Door widths shall not exceed three feet.
 - f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
 - g. Provide oil resistant gasket completely around each door or opening.
 - h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
 - i. Use stainless steel fasteners throughout.
 - j. Provide interior mounting panels and shelves constructed of minimum 12-gage steel with white enamel finish.
 - k. For prints, provide steel pocket with white enamel finish.
 - l. Provide enclosure mounting supports as required for floor, frame, or wall mounting as required.
 - m. Completely clean interior and exterior surfaces so surfaces are free of corrosive residue, oil, grease, and dirt. Zinc phosphatize for corrosion protection.
 - n. Provide one coat of primer paint to interior and exterior surfaces immediately after applying corrosion protection, in accordance with coating manufacturers' instructions. Provide surface preparation in accordance with coating manufacturer's requirements.
 - o. Paint interior surfaces with two coats of semi-gloss white polyurethane enamel.
 - p. Paint exterior surfaces with minimum of three finish coats of polyurethane enamel to produce a finish that is smooth and free of imperfections. Color shall be selected by ENGINEER from complete selection of standard and custom color charts furnished by manufacturer.
 - q. Primer and finish paint shall be compatible and shall be low-VOC, high-solids polyurethane enamel.
2. Control panels located in non-environmentally controlled areas and outdoor areas shall be rated NEMA 4X and with the following features:
 - a. Panels shall be Type 316L stainless steel construction with minimum thickness of 12-gage for all surfaces, except areas requiring reinforcing, with a smooth-brushed finish.
 - b. Stainless steel screw clamp assemblies on three sides of each door.

- c. Rolled lip around three sides of door and along top of enclosure opening.
 - d. Hasp and staple for padlocking.
 - e. Provide clear-plastic, gasketed lockable hinged door to encompass non-NEMA 4X front-of-panel devices.
3. Control Panels Located in Hazardous Rated Areas (NEMA 7):
- a. General: Provide explosion-proof enclosures, suitable for use in NEC Class 1, Groups C and D or Class II, Groups E, F and G applications and comply with UL 2062 .
 - b. Required Features:
 - 1) Lightweight and corrosion-resistant copper-free aluminum.
 - 2) Integral, cast-on mounting lugs.
 - 3) Left side door hinges.
 - 4) Viewing windows sized to suit internally-mounted components.
 - 5) Stainless steel cover bolts.
 - 6) Cadmium-plated steel mounting pans.
 - 7) Enclosed heat-generating devices shall not cause external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in surrounding atmosphere.
 - 8) Mark panels with appropriate class and group(s) for which panel is qualified. Panels shall comply with features and test criteria of NEMA 250.
4. Wall-Mounted Panels:
- a. General: Wall-mounted panels shall comply with applicable features and standards specified in this Section for the associated NEMA-rated panel.
 - b. Unless otherwise indicated or approved by ENGINEER, depth of wall-mounted panels shall not exceed 18 inches.
 - c. Panels may be all stainless steel, fiberglass, polycarbonate, or acrylonitrile butadiene and styrene (ABS).
 - c. Provide appropriate size and number of external mounting feet.
 - d. Drilled holes or knockouts in back of wall-mounted panels are not allowed.
 - d. Provide corrosion-resistant polyester quick release latches (for non-stainless-steel panels) or stainless-steel screw clamp assemblies (for stainless steel panels).

D. Electrical Systems:

- 1. Power Source and Internal Power Distribution:
 - a. Provide in the panel, near where incoming power is terminated, nameplate with panel power supply source, type, voltage, and circuit number.
 - b. Protect incoming 120 vac power feeds to power the panel by providing lightning and surge arrestors, properly connected to grounds.
 - c. Provide panels with internal 120 vac power distribution system with properly-sized and -rated circuit breakers to distribute power. Power not more than six devices from a single breaker. When power supplies are included in the panel, not more than two power supplies shall be powered from a single breaker. Convenience receptacles and interior panel lights shall have their own breakers. When one or more field instruments

require 120 vac power from the panel for instrument power, power not more than three instruments from a given breaker.

d. Provide space for a minimum of two spare breakers in each panel.

2. Electrical Systems:

a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 volts at 85 degrees C for single conductors, color-coded and labeled with wire identification.

b. For DC signal wiring, use shielded cable with 18-gage conductors. DC field signal wiring terminal strips shall be capable of handling wires up and including No. 12 size.

c. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 amps, use sizes required by the NEC (NFPA 70) .

d. Inside of panels, route DC signal wiring separately from power wiring with minimum separation distance of six inches.

e. Use covered panduits to route internal panel cables and wiring. Panduits in each section of panel shall be appropriately sized to accommodate the quantity of wires to be routed with a spare capacity of 40 percent.

f. Install wire troughs inside panels along horizontal or vertical routes to present a neat appearance. Angled runs are unacceptable.

g. Wiring that is routed without panduits shall be adequately supported and restrained to prevent sagging or other movement. Use of adhesive anchors to support or restrain wiring is unacceptable.

h. Terminate internal panel wiring using tube, insulated, crimp-on connectors; soldered connectors are unacceptable. use screw type terminal blocks 600-volt rated, mounted on DIN rails. Fused terminal blocks shall have LED blown fuse indication. Terminal blocks for 4-20 mA signals shall be fused and knife disconnect terminal blocks. Use of Two-Level terminal blocks is not acceptable. Terminal strips shall be identified as specified in this section. Identifiers shall be self-stick, plastic tape strips with permanent type, machine printed numbers. Hand-written labels are not acceptable.

i. Wiring in panels shall be installed such that, if wires are removed from any one device, power will not be disrupted to other devices.

j. Provide spare terminals equal in number to 20 percent of terminals used for each type of wiring (e.g., DC signal and AC power).

k. Provide ground terminals to terminate the shield wire of shielded cables. Termination of more than two shielded wires on a single ground terminal is unacceptable.

l. Provide a single copper bus bar with 5/16-inch diameter copper grounding stud to connect the panel to external ground. Panel's internal grounds shall be terminated to the bus bar.

m. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.

n. When DC power or low voltage AC power is required, furnish and install in the panel required power supplies and transformers.

o. Provide complete wiring diagram of "as-built" circuitry enclosed in transparent plastic.

2.4 MAIN AND BRANCH CIRCUIT BREAKER

A. General:

1. Circuit breakers shall be furnished and installed in control panels to provide automatically operated switch protection in an electrical circuit from damage caused by an overload or short circuit.
2. Branch circuit breakers shall be approved for branch circuit applications in the United States.

B. Features:

1. Type: High Density Circuit Breaker.
2. Provide Single Pole 120/240V breakers within the control panels.
3. Rating: Provide breakers with proper amp rating to protect the circuit it serves. Normal operating load of each circuit shall be noted on the panel power distribution wiring drawing.
4. Insulation Resistance: 100M-ohm at 500VDC.
5. Terminal Type: Tubular screw with self-lifting box lug.
6. Push-to-set mechanism for circuit actuation.
7. Manual trip button.
8. DIN rail mounted.
9. Status on/off indicator lights
10. Compliance: UL 1077 Listed, CSA C22.2 No. 235, EN/IEC 60934.

C. Products and Manufacturers:

1. Phoenix Contact.
2. Or Equal.

2.5 UNINTERRUPTIBLE POWER SYSTEM

A. General:

1. Uninterruptible Power System (UPS) shall be furnished to provide a reliable source of uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.
2. A UPS shall be provided for the Main Control Panel and shall provide power backup to all internal components including:
 - a. Gas monitoring horns and strobe lights.
 - b. Wet well H₂S sampling pump.
 - c. Mission Control System.

- ### B. Description:
- On line dual track power conditioner and true (0 ms transfer time) uninterruptible power supply providing isolation, line regulation and conditioning, using sealed 48 VDC maintenance free batteries and switch mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.

C. Features:

1. Unit shall provide uninterrupted conditioned power, under fully loaded conditions, for 20 minutes. Unit shall be sized to accommodate power requirements for all equipment it is to power for the required length of time and shall provide ten percent spare output capacity at minimum.
2. Rating: Provide 3.0KVA minimum. Support submitted model with UPS load calculation. Ratings less than 3.0KVA are subject to approval by Engineer and must have load calculation basis.
3. Lighting and Surge Protection: Inherent 2000: One spike attenuation.
4. Regulation: One to three percent load regulation with less than 2pF effective coupling capacitance for line to load.
5. Output Waveform: Computer grade sine wave with three percent maximum single harmonic and five percent maximum total harmonic distortion.
6. Output Frequency: 60 Hz $\pm$ 0.5 Hz.
7. Operating Temperature: 1°C to 40°C.
8. Relative Humidity: Five to 90 percent non-condensing.
9. Normally Closed contact output for Battery Low and UPS fail alarms to be connected to a PLC discrete input.
10. Input Protection: Independent battery charger fuse and DC fuses.
11. Output Protection: Inherently current limited ferro-resonant transformer.
12. Battery Charger: Two-step charger, 8 A and 2 A.
13. AC Input: 120VAC, 60Hz, single phase, +15 percent, -20 percent.
14. AC Output: 120VAC, 60Hz, single phase, +3 percent, -3 percent.

D. Products and Manufacturers:

1. American Power Conversion Corp. (APC)
2. Or Equal.

2.6 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

A. General:

1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
2. Type:
 - a. 30.0 mm, heavy duty, oil tight.
3. Provide legend plate for indication of switch, pushbutton or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").
4. Mounting: Flush mounted on control panel front, unless otherwise noted.
5. NEMA rated to match panel in which they are mounted.

B. Selector Switches:

1. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.
2. Contacts:
 - a. Provide number and arrangement of contacts as required to perform intended functions specified, but not less than two single pole, double throw contact.

- b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.
 - c. Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than 10 A resistive at 120 VAC or DC continuous.
 - 3. Switch Operator: Standard black knob.
- C. Pushbuttons (Standard or Illuminated):
 - 1. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.
 - 2. Contacts: Comply with the requirements specified for selector switches.
- D. Indicating Lights:
 - 1. Type: Light-Emitting Diode (LED).
 - 2. Lamps: 2.2 volt, long life (20,000 hours minimum).
- E. Button and Lens Colors:
 - 1. Red for indication of open, on, or running.
 - 2. Green for indication of closed, off (ready), or stopped.
 - 3. Amber for indication of equipment malfunction, process trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.).
 - 4. White for indication of electrical control power on.
 - 5. Blue for indication of remote.
- F. Products and Manufacturers:
 - 1. Allen Bradley.
 - 2. Eaton Corp.
 - 3. Or equal.

2.7 CONTROL RELAY (ICE CUBE TYPE)

- A. Type: General purpose, plug-in Ice-cube type rated for continuous duty.
- B. Construction Features:
 - 1. Coil Voltages: 24 VDC or 120 VAC, as required.
 - 2. Contacts: DPDT or 4PDT.
 - a. Silver cadmium oxide rated not less than 10 A resistive at 120 VAC or 24 VDC continuous.
 - b. For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 5 A resistive at 120 VAC or 28 VDC continuous shall be provided.
 - 3. Relays to have clear plastic dust cover.
 - 4. Relays to have pilot light to show energized coil.
 - 5. Relay to have push-to-test and manual override.
 - 6. Relays to be UL recognized.
- C. Products and Manufacturers:
 - 1. Allen Bradley.

2. Square D Company.
3. Or equal.

2.8 POWER SUPPLIES

- A. Provide a 24 VDC power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.
- B. The 24 VDC power supply shall meet the following requirements:
 1. Input power: 115 vac, plus or minus 10 percent, 60 Hz.
 2. Output voltage: 24 vdc.
 3. Output voltage adjustment: 5 percent.
 4. Line regulation: 0.05 percent for 10 V line change.
 5. Load regulation: 0.15 percent no load to full load.
 6. Ripple: 3 mV RMS.
 7. Operating temperature: Full output current between -32 to 140 degrees Fahrenheit.
 8. DIN rail mounting.
 9. Integrated Selective Fused Breaking.
 10. Local and remote fail indication.
- C. Size the 24 vdc power supply to accommodate the design load plus a minimum 30 percent spare capacity. Provide load calculation.
- D. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.
- E. Mount the 24 vdc power supply such that dissipated heat does not adversely affect other panel components.
- F. Provide a Power Supply Diode Redundancy module from the same manufacturer of the power supplies.
- G. Products and Manufacturers:
 1. Phoenix Contact Quint Power.
 2. Or Equal.

2.9 PROGRAMMABLE LOGIC CONTROLLER (PLC)

- A. The final system configuration shall utilize the System Manufacturer's standard hardware and software to meet the functional requirements of these Specifications.
- B. All equipment furnished under this Contract shall be provided to meet the functional requirements of these Specifications plus a 20 percent growth in project requirements, (e.g., graphic displays, alarms, additional instrumentation and equipment). All equipment shall be provided under this Contract, such that the

entire 20 percent project growth can be implemented into the PLC, without any additional hardware cost to the Owner.

- C. The PLC shall have the ability to communicate with multiple remote I/O racks, or devices configured with multiple I/O modules. The PLC shall have the ability to support multiple data communications networks in the same chassis
- D. Assembled System:
 - 1. Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded to meet the manufacturer's specifications.
 - 2. Provide a dry contact rated at 2 amperes and 120 volts a-c for remote indication of processor failure.
 - 3. PLCs shall be capable of being programmed and updated where installed.
 - 4. Provide interposing relays for all digital outputs to motor control centers, solenoids or contactor circuits.
 - 5. Provide individual fuses for all analog inputs and outputs. Fuses shall be capable of being inspected without removal of and replaced without disassembly of the terminal block.
- E. The PLC shall perform the following functions:
 - 1. Functions to be performed by the PLC include, but are not necessarily limited to, the following:
 - a. Generate alarms based on inactive and active input and output and based on analog values.
 - b. PID control and arithmetic functions.
 - c. Interlock and sequential logic control of processes and equipment operations.
 - d. User program executions.
 - e. Collection and transmission of data and control parameters to and from other PLC's and workstations with Operator Interface Terminal (OIT) software.
 - 2. The manipulative functions shall have the capability of being rearranged into any desired format while the controller is performing other control tasks.
 - 3. The control programs and applications memory of the PLC shall be capable of being remotely (off-line) and locally (on-line) monitored, programmed, modified and displayed by use of a personal computer and documentation software which shall be provided as part of this contract.
- F. Required Features:
 - 1. Construction: Modular printed circuit boards.
 - 2. Memory: The CPU shall be a microprocessor with onboard Dynamic Random-Access memory (DRAM) and flash memory for read/write functions and storage of configured data without battery backup. The microprocessor shall have:
 - a. Minimum of 2.0 M Bytes of User memory.
 - b. Nonvolatile memory storage: 1GB, SD Type.
 - 4. A minimum of 20 percent spare rack space shall be provided for future card additions.

5. Power Supply: 120 vac, with fuse or circuit breaker protection. Supplies shall be sized for a minimum of 130 percent of maximum simultaneous current draw in accordance with the General Design Requirements in article 2.1. Power Supplies shall incorporate full power factor correction, AC input filtering, and a 40 millisecond hold up time.
6. Clock: Real-time battery-backed clock with typical variation of 2 seconds in 6 months to provide time reference for processor and system operation. Also provide timer for monitoring system software operations to detect hardware malfunction or a non-productive loop (stall condition).
7. Current Input Module:
 - a. 4-20 mADC.
 - b. Maximum of 8 isolated input channels per module.
8. Current Output Module:
 - a. 4-20 mADC.
 - b. Maximum of 8 isolated output channels per module.
9. Discrete Digital Input Module:
 - a. 120VAC voltage monitor.
 - b. Maximum of 16 individually isolated input channels per module.
10. Discrete Digital Dry Contact Output Module:
 - a. Relay output (NO contacts, 120VAC 2A minimum).
 - b. Maximum of 16 individually isolated output channels per module.
11. Ethernet Interface Module:
 - a. Standard Ethernet media (10baseT, 100baseT, and fiber).
 - b. RJ-45 interface.
 - c. Standard TCP/IP communications.
 - d. Subnet masking.
 - e. Provide one for the communication with remote IO and other devices in a ring topology network and provide other module for communication with future SCADA System.
12. Redundant System:
 - a. The PLC redundancy system shall provide higher system availability. This shall be realized by switching control to a secondary controller chassis if anything in the primary controller chassis.
 - b. The redundancy system shall allow connecting to other (remotely located) networks using the bridging functionality of other communication modules.
 - c. Use fiber optic media to connect the primary and the secondary control system.
 - d. The switch over between primary and secondary controller shall happen transparent to the user and to the application.
 - e. In event of a switchover, the PLC redundancy system shall automatically swap communication modules' addresses between primary and secondary chassis. Any external device shall continue to communicate with the new primary controller.
 - f. The PLC redundancy system shall guarantee a bumpless switchover for any outputs point.
 - g. The PLC redundancy system shall provide an automatic program cross-load and synchronization. The program shall be downloaded only to the

primary controller. Using this design, it shall eliminate the need for maintaining separate programs for the primary and the secondary controllers. A controller, configured as a secondary controller, shall automatically receive and buffer data changes from the primary controller.

13. Modbus RTU Communicaiton Module:
 - a. RJ-45 interface.
 - b. Two ports minimum.
14. I/O Chassis:

Number of slots as needed.
15. Power Supply (PS):
 - a. 120VAC input voltage.
 - b. Minimum current output as required to power all local PLC modules.

G. Product and Manufacturer

1. Allen Bradley Control Logix Platform
2. Schneider Electric Modicon M580 epac Controller
3. Or Equal.

2.10 PLC PROGRAMMING SOFTWARE

- A. Software shall support the development of the PLC ladder logic derived from process control strategies as specified herein. Software shall be IEC 1131-3 compliant Ladder Diagram as well as modular, function block type of control elements, which are familiar to control system programmers and engineers, instrumentation technicians and electricians. The function blocks shall be computational blocks for performing arithmetic, operational blocks for performing such functions as move and convert values, file to file operations, communication blocks for communicating with other PLC's and system resources, special algorithm blocks for advanced control procedures such as shift register, and PID functions. The PID shall use traditional strategies such as Proportional Integral Derivative (PID) controllers, feed forward, cascaded controllers, etc. shall be provided. Tuning constants shall be easily set from operator consoles. For each analog loop, software to allow provision of status of the manual backup control to be monitored and an alarm generated when switch is not in automatic mode.
- B. For each sequence or logic control loop, a disagreement alarm shall be triggered when a command (start-stop, etc.) is initiated and confirmation is not received.
- C. Software shall allow configuration of internal diagnostics alarms for the PLC hardware. Alarms shall be suitable to verify proper and to alert operators when alarm conditions occurs. This includes, but is not limited to annunciation blown fuse indication for all I/O, watchdogs for communications failure with any system processor or I/O address, and communications failure with existing third-party equipment.
- D. PLC software shall allow for editing of comments and other PLC documentation using traditional editors such as Notepad.

- E. PLC software shall include as easy to use file and printing management module.
- F. The PLC software shall use intuitive, menu-driver environment and base package platform. These easy-to-use Graphical User Interface (GUI) packages shall perform configuration and maintenance operations.
- G. The PLC software shall be compatible with 64 bit computers and Windows 10 professional or latest version.
- H. The PLC software shall be fully compatible with all furnished PLC hardware.
- I. Product and Manufacturer: Product and manufacturer must match and be applicable for PLC hardware platform selected. Provide full licensing product and all necessary package add-ons, software and features to allow programming and maintenance of the PLC network as shown.

2.11 OPERATOR INTERFACE TERMINAL (OIT)

- A. Provide a programmable Operator Interface Terminal (OIT) to enable Operator to control and monitor field equipment. The OIT unit shall be flush panel mounted on the front of the panel. OIT unit shall be provided with all necessary hardware, cables and software to accomplish the interface as specified herein and shown on the Contract Drawings.
- B. Performance Requirements:
 - 1. The OIT shall be designed to be connected to the remote I/O or Ethernet network and shall be able to transfer up to twenty-two 64 word blocks each way.
 - 2. The OIT shall be provided with off-line development software which allows development of graphic picture files, touch screen key files, alarm files, trend files, system configurations, variables, and screen definitions. Provision shall be made to store commonly used symbols and screen definitions.
 - 3. Provide latest version of configuration software and license.
- C. Each OIT shall be provided with the following minimum requirements:
 - 1. Display: 15-inch Active Matrix Color TFT, 640 x 480, 18-bit Color, analog touch screen.
 - 2. Field replaceable Backlight.
 - 3. Memory: Available Flash: 64MB; RAM: 64MB.
 - 4. Communication: Ethernet supporting ring topology.
 - 5. Input Voltage: 18 – 32VDC.
 - 6. Power Consumption: 70 Watts (maximum).
 - 7. Operating Temperature: 0 – 55 degrees Celsius.
 - 8. Humidity: 5 - 90% without condensation.
 - 9. Rating: NEMA 4X, UL-listed.
- D. Product and Manufacturer:

1. Allen Bradley PanelView Plus Series.
2. Schneider Electric Magelis XBT GT Series
3. Or Equal. Unless otherwise approved by the Engineer, the Operator Interface manufacturer shall match the PLC manufacturer.

2.12 MISSION CONTROL

- A. Provide configuration as indicated on P&IDs for displays and inputs from MCP PLC to the Mission Control system. See Input/Output List for points to be configured. See P&ID Sheet I-2 for relevant notes.
- B. Include additional Digital Option Board(s) to expand the capacity for total of 16 Digital Inputs. Provide all appurtenances, wiring, terminal blocks or other required materials to allow integration of the 16 digital inputs. If necessary to accommodate the additional points, provide a larger enclosure to house the Mission system. Ensure that two Analog Inputs are available for Flow and Pressure monitoring.

2.13 PRESSURE GAUGES

- A. Bourdon Tube Pressure Element Type, Liquid Filled Gauges (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inch Hg):
 1. Performance Requirements:
 - a. Accuracy: ± 0.5 percent of span (ANSI B40.1 Grade 2A).
- B. Construction Features:
 1. Case:
 - a. Solid front design constructed of glass filled polyester.
 - b. Color: Black.
 2. Ring: Threaded, glass filled polyester.
 3. Full blowout back.
 4. Window: Glass.
 5. Dial: White with black marking; 270-degree scale.
 6. Bourdon Tube and Socket: Type 316 Stainless Steel, heliarc welded, unless otherwise specified in the Field Instrument List.
 7. Movement: Cam and roller movement, 300 series stainless steel.
 8. Size: 4-1/2-inch.
 9. Connection: 1/4-inch male NPT back or bottom, as required.
 10. Mounting: Stem, flush panel or wall mounting, as required.
 11. Adjustable pointer.
 12. Externally accessible zero adjustment.
 13. Built-in overload and underload movement stops.
 14. Pressure Snubber: Sintered stainless steel snubber threaded into gauge socket or in external stainless-steel housing with 1/4-inch NPT male and female connections.
 15. Filling Liquid: Silicone oil.
 16. Process Isolation: Provide gauge cocks or ball valves for process isolation.
 17. Provide diaphragm seal, except for air or potable water applications.

- C. Products and Manufacturers: Provide one of the following:
 - 1. Series 900, as manufactured by Helicoid.
 - 2. Or equal.

2.14 DIAPHRAGM SEALS

- A. General: Furnish diaphragm seals at locations shown and specified for pressure gauges and switches.
- B. Construction Features required for all seals:
 - 1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
 - 2. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
 - 3. Instrument Connection: 1/4-inch NPT.
 - 4. Process Connection: 1/2-inch NPT.
 - 5. Working Pressure Rating: Equal to or greater than the attached gauge or switch operating pressure range or the connected process piping system test pressure whichever is greater.
 - 6. Bolting Materials: Type 316 stainless steel.
- C. Seal Construction Features:
 - 1. All Alloy 20, except for water service which shall be Type 316 stainless steel.
- D. Assembly and Calibration:
 - 1. The complete diaphragm seal assembly, including gage or switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch set points specified prior to shipment.
 - 2. System Supplier shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage, switch or transmitter accuracy over the specified measurement range or at switch set points specified in the Instrument List.
 - 3. Location and orientation of the gages, switches and seal assemblies shall be coordinated with the actual piping and equipment installations so that gages and indicators shall be easily read and accessed for maintenance by plant personnel.
 - 4. Where field mounting and orientation conflicts arise due to incomplete coordination with or field changes in the process piping and equipment installation, assemblies shall be relocated, re-oriented, re-assembled and re-calibrated as directed by the ENGINEER, in writing.
- E. Products and Manufacturers: Provide one of the following:
 - 1. Type 100 HAC, as manufactured by Helicoid.
 - 2. Or equal.

2.12 PRESSURE TRANSMITTERS

- A. Type: Two-wire, differential capacitance or resonant wire type transmitters.
- B. Function: Measure a pressure (gauge (G) and produce an analog output signal directly proportional to that pressure. For liquid flow measurement applications using differential pressure transmitters, integral square root extractors shall function to produce an analog output linearly proportional to flow rate.
- C. Performance Specifications:
 - 1. Accuracy (includes combined effects of linearity, hysteresis and repeatability): ± 0.25 percent of calibrated span.
 - 2. Repeatability: 0.05 percent of calibrated span.
 - 3. Hysteresis: 0.05 percent of calibrated span.
 - 4. Stability (drift over a six-month period):
 - a. All Transmitters: Not more than ± 0.25 percent of transmitter upper range limit.
 - 5. Ambient Temperature Effect: Total Error per 100°F change between the limits of -20°F and +180°F:
 - 6. Supply Voltage Effect: Output change not greater than 0.005 percent of span for each one volt change in supply voltage.
 - 7. Output: 4 to 20 mADC direct acting into 0 to 575 ohms minimum at 24 VDC supply voltage.
- D. Required Features and Accessories:
 - 1. Solid state electronic components.
 - 2. Positive overrange protection of at least 1.25 times the maximum span limit.
 - 3. Calibration Adjustments:
 - a. Zero: Adjustable with external adjustment screws located behind protective hinged cover.
 - b. Span: Coarse and fine span adjustments in electronics compartment.
 - 4. Zero Elevation and Suppression Capability to the extent that the amount of suppression plus calibrated span does not exceed the upper range limits of the sensor.
 - 5. Adjustable internal damping.
 - 6. Measuring elements protected by sealing diaphragm.
 - 7. Built-in electrical surge and RFI protection.
 - 8. Valves:
 - a. Provide a single shutoff valve at each process line tap to enable live process removal of transmitter.
 - b. Provide Type 316 stainless steel three valve manifold for shutoff and pressure equalization on differential pressure and flow measurement applications.
 - 9. Integral square root extraction providing 4 to 20 mADC output linearly proportional to flow (over 20 to 100 percent flow range) for liquid flow measurement applications.
 - 10. Electrical Conduit Connection: 1/2-inch NPT.
 - 11. Process Connections: 1/2-inch NPT.

12. Designed to operate on power from receiver or remote power supply, nominal 24 VDC.
 13. Stainless steel mounting bracket and hardware suitable for mounting transmitter on flat vertical surface or 2-inch diameter pipe.
 14. Process Wetted Parts: Type 316 stainless steel.
 15. Non-Wetted Parts:
 - a. Body and Process Connection Bolting: Stainless steel.
 - b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; covers to be threaded and seats on Buna-N O-rings, NEMA 4 rating.
 - c. Capsule Fill Liquid: Silicone oil.
 16. Indicator: Provide integral indicator with 0 to 100 percent scale and stainless-steel tag to indicate 100 percent value of range in engineering units.
 17. Hazardous Area Requirements: Where so required, provide transmitters rated for use in Class I, Group D, Division 1 hazardous areas.
- E. Products and Manufacturers: Provide one of the following:
1. 1151 Series, as manufactured by Rosemount, Incorporated.
 2. 820 Series, as manufactured by Foxboro Company.
 2. Or equal.

2.13 LEVEL TRANSMITTER-SUBMERSIBLE PRESSURE TYPE (WASTEWATER)

- A. Type: Measuring level by continuously measuring hydrostatic pressure via its sensing element, an ion implanted silicon semiconductor chip. Data is transmitted by an analog, 4 to 20 mADC output signal.
- B. Performance Requirements:
1. Accuracy: ± 0.25 percent full scale.
 2. Zero Offset: ± 0.50 percent full scale.
 3. Span: ± 0.50 percent full scale.
 4. Temperature Ranges: -4 to 140 degrees F.
- C. Construction Features:
1. Diaphragm: Minimum 2.5" diameter, Type 316L stainless steel.
 2. Housing: Type 316 stainless steel.
 3. Cable shall be provided of required length to connect back to the Level Monitoring Panel, and shall be field verified. Cable shall be suitable for full submersion along its entire length.
 4. Power supply: 12 to 28 VDC with surge and lightning protection.
 5. Electrical Connection: Attached 3-wire, 20 gauge polyethylene shielded unsplined cable.
 6. Panel mounted meter shall be factory calibrated for required range, shall accept 4 to 20 mADC input, shall have a 3-1/2 digit vacuum fluorescent display in feet of water, shall be NEMA 4X rated and have two relay outputs for low level alarm.

7. Provide cable weight and all mounting appurtenances, including 12" PVC pipe to act as a stilling well. Coordinate mounting requirements with Section 06611, Fiberglass Reinforced Plastic Gratings, and Plate.
- D. Manufacturers: Provide products of one of the following:
1. Ametek Model 575P
 2. KPSI 750 Series Unit
 3. Blue Ribbon Birdcage Model BC001
 4. Or equal.

2.14 FLOAT LEVEL SWITCH

- A. General: The device shall be capable of detecting fluid level and initiating a signal.
- B. Type: Direct acting float, non-mercury.
- C. Required Features:
1. Sealed SPDT control switch.
 2. Actuation by steel ball.
 3. High impact, corrosion resistant, PVC float material.
 4. Heavy duty neoprene jacketed cable with waterproof connection. Cable length shall be as required.
 5. Not sensitive to rotation.
 6. Operating Temperature: 0 to 140°F.
 7. Provide cable weight and all mounting appurtenances.
- D. Products and Manufacturers: Provide one of the following:
1. Flygt ENM 10 Float Switch Series
 2. Signalmaster, as manufactured by S.J. Electro Systems, Inc.
 3. Or equal.

2.15 THERMAL MASS FLOW SWITCH

- A. General: Thermal Differential Mass Insertion Flow Switch for the detection of mass flow rate of liquids and gases.
- B. Type: Thermal Differential Dual RTD Sensors.
- C. Performance Requirements:
1. Operating Range: 0.01 ft/s to 3.0 ft/s water.
 2. Response Time: Sensor response time 0.5 seconds.
 3. Repeatability: $\pm 1\%$ of setpoint
 4. Operating Temperature Range: -40 to 140 degrees F
- D. Construction Features:
1. Sensor: 316 Series Stainless Steel.
 2. Power supply: 120 VAC.
 3. Enclosure: Explosion Proof: NEMA 4X and UL Approval

E. Products and Manufacturers: Provide one of the following:

1. Fluid Components International
2. Kurz Instruments
3. Or equal.

2.15 MAGNETIC FLOWTUBE AND TRANSMITTER

A. Type: Flowtube with pulsed DC Magnetic Flow Transmitter.

B. Function: Monitor liquid flows as shown. The transmitter shall display the monitored flow value and shall output a 4 to 20 mADC signal proportional to the monitored flow.

C. Performance Requirements:

1. Range: 0 – 10000 GPM.
2. Accuracy (with analog output):
 - a. ± 0.5 percent of flow rate, or better, over a range from 1 fps to 31 fps.
 - b. ± 0.005 fps, or better, at flows below 1 fps.
 - c. Accuracy unaffected by changes in fluid velocity, density, pressure, temperature or conductivity (above minimum conductivity limits).
 - d. System accuracy shall be proven by submittal of flow test curves of the actual meters being furnished.
 - 1) Test curves shall show a minimum of ten equally spaced flow points. Tests shall be performed using water and a weight or volume tank. A “master meter” used as a reference standard is not acceptable. The test setup shall be submitted and approved prior to testing.
4. Repeatability: ± 0.15 percent of flow rate, or ± 0.0015 fps, whichever is greater.
5. Drift: Complete zero stability.
6. Minimum Fluid Conductivity Limit: Five microsiemens per centimeter or less.
7. Minimum Pre-amp Input Impedance: 1012 ohms.
8. Power:
 - a. 120 VAC ± 10 percent, 60 Hz, ± 3 Hz power supply.
 - b. Power Consumption shall not exceed 50 watts for flowtube and transmitter combined.
9. Output:
 - a. 4 to 20 mADC, direct acting and isolated, into 0 to 1000 ohms.
 - b. High accuracy, field adjustable scaled pulse output (0.1 to 10 Hz or greater) to drive local totalizer.
10. Operating Temperature: Suitable for operation with process fluid temperature from 0° to 140°F.
11. Pressure Rating: Greater than or equal to test pressure specified in Section 40 05 05, Exposed Piping Installation, for appropriate piping system.

D. Construction Features

1. Flowtube:

- a. Type: Lined metal flowtubes.
 - b. Interchangeability: Ratio of flow velocity to voltage reference signals generated identical for all meter sizes to permit interchangeability with transmitter without requiring circuit modifications.
 - c. Tube Material: Type 304 stainless steel.
 - d. Electrode:
 - 1) Conical or elliptical shaped.
 - 2) Material: To be compatible with the process fluid, raw sewage/wastewater application.
 - e. Lining: To be compatible with the raw sewage/wastewater application.
2. Enclosure:
- a. Materials and Rating:
 - 1) Cast low-copper aluminum alloy or fabricated sheet steel.
 - 2) NEMA 6 rated.
 - 3) Capable of withstanding accidental submergence in 30 feet of water for 48 hours.
 - b. Finish: Finish exterior, except for flange faces, with a high build epoxy paint.
 - c. End Connections: ANSI Class 150 suitable for mating with pipe specified.
 - d. Electrical Connections: 3/4-inch NPT tapped holes for power conduit fitting and signal conduit fittings.
3. Pulsed DC Magnetic Flow Transmitter:
- a. Materials and Rating:
 - 1) Die cast, low-copper aluminum alloy.
 - 2) NEMA 4 rated.
 - b. Solid state construction.
 - c. Local Indication:
 - 1) 3-1/2 digit minimum LCD meter with field selectable engineering units.
 - 2) Seven-digit electromechanical totalizer or eight digit electronic LCD totalizer with reset and lithium battery backup. Totalizer shall be integral with transmitter and visible through viewing window, or shall be externally mounted in a separate NEMA 4X enclosure or conduit with viewing window and installed adjacent to the transmitter.
 - d. Pulse and analog outputs galvanically isolated from input and earth ground.
 - e. Automatic zeroing feature making it unnecessary to zero the instrument before or after placing it in operation.
 - f. Pre-calibrated span adjustment providing continuous span adjustment over entire range.
 - g. Range Adjustment: Direct reading thumbwheel switches or calibrated potentiometer, continuously adjustable for full scale settings from 1 to 31 feet per second.
 - h. Signal Conditioning: Adjustable damping circuit with response times of 1 to 25 seconds minimum.

- i. Low Flow Cutoff: Provide automatic low flow cutoff circuitry to stop pulse output and local totalization when flow drops below 0.5 percent $\pm$ 0.2 percent of the calibrated upper range valve.
- E. Accessories:
 - 1. Mounting:
 - a. Provide complete Type 316 stainless steel mounting hardware.
 - b. All transmitter and driver electronics shall be remotely mounted from the flow tubes at locations shown.
 - c. Type of mounting (wall, support frame or pipe stand) as required.
 - 2. Shielded cable assemblies of sufficient length for connection between flowtube and transmitter electronics.
 - 3. Type 316 stainless steel grounding rings for flowtubes.
 - 4. Type 316 stainless steel grounding straps.
 - 5. NEMA 4X rated 120 VAC power on-off selector switch as specified in Article 2.2, above.
 - 6. A spool piece for replacement of each different size flow tube where no bypass piping is provided.
 - 7. One calibrator suitable to calibrate all flow tubes provided.
- F. Products and Manufacturers: Provide one of the following:
 - 1. Endress and Hauser Promag 400 W Series.
 - 2. Or equal.

2.16 GAS MONITORING SYSTEM

- A. General: Each Gas Monitoring System shall measure and display gas concentration and provide alarms when preset limits are exceeded. A Gas Monitoring System shall consist of 3 transmitters, 3 sensor extension kits (where applicable), 3 transmitting cables (where applicable), 3 monitors, calibration kits for each type of gas and local alarm devices (strobe light, horn, test switch and safety sign. The Gas monitoring system shall be capable of detection of LEL, Hydrogen Sulfide and Oxygen. The system shall also include Sampling Pump for Hydrogen Sulfide measurement near the wet well area. Multiplexing of sensor signals is unacceptable.
- B. Methane System Required Features:
 - 1. Sensor:
 - a. Detection: IR Combustible 0-100% LEL - Methane.
 - b. Accuracy: Linearity - $\pm$ 2% full scale (Less than 50% LEL).
 - c. Repeatability: $\pm$ 1 percent full scale.
 - d. Drift: Zero – $\pm$ 2% year/ typically.
 - e. Response Time: Less than 60 seconds to read 90 percent of step change.
 - f. Drift: $\pm$ 1 percent of full scale per week.
 - g. Noise: Less than 1% full scale.
 - h. Response Time: Less than 2 seconds to 90% of test gas concentration.
 - i. Power Input: 24 V DC @750 mA maximum.
 - j. Enclosure Type: 316 Stainless Steel, UL Approved, 3/4" NPT Threads, with a minimum of 4 entries.

- k. Enclosure: NEMA 7 (explosion proof)
 - l. Sensor Material: 316 Stainless Steel.
 - m. Sensor Mounting Style: Single Condulet (remotely mounted from electronics and display).
 - n. Calibration: The sensor shall be calibrated remotely using tubing going from transmitter display to the sensor.
 - o. Sensor Life/Warranty: 10 years typical, with 10 years warranty from manufacturer.
 - p. Sensor Guard: Provide for protection from moisture and dust.
 - q. Installation Hardware: Provide Mounting Kit as required for installation.
2. Transmitter:
- a. Type: With integral display and capable of non-intrusive intrinsically safe calibration.
 - b. Transmitter electronics: one single PCB for increased reliability. The PCB shall offer expandability to allow up to 4 relays.
 - c. Transmitter Power: 24 V DC, supplied over 3-Wires current source.
 - d. Transmitter Output: 4-20 mA non- isolated linear; Isolated output non feasible with on-board relays and catalytic sensors.
 - e. Transmitter Display: 3 ½" Digit LCD; shall indicate power on, gas concentration, alarm and fault conditions. Visible from a minimum of 5 feet and shall be present at all times; Alternate between type and gas concentration End of sensor life, and sensor sensitivity display required.
 - f. Installation Hardware: Provide mounting kit as required for installation.
3. Sensor/Transmitter Approvals:
- a. UL 1203 & Factory Mutual (FM) - Class 1, Div. 1 & 2 Groups A, B, C, & D hazardous atmospheres.
4. Calibration: Detection system (sensor/transmitter) shall be factory calibrated. Manufacturer certified calibration required. Include calibration kit with gases and handheld remote control.
5. Tagging: 316 SS engraved tag for sensor and transmitter required. See contract drawings for locations of the sensors.
6. All hydrocarbon sensors shall be mounted where indicated on drawings.
7. Accessories:
- a. Interconnecting Cable – Provide as requested.
8. Product and Manufacturer: Provide one of the following:
- a. Ultima XIR-38 for hydrocarbon detection, as manufactured by MSA.
 - b. Infiniti U9500H transmitter, with Det-Tronics PointWatch infrared hydrocarbon gas detector only, as manufactured by Det-Tronics.
 - c. Or equal.

C. Hydrogen Sulfide System Required Features:

- 1. Sensor:
 - a. Sensor Detection: Electrochemical Hydrogen Sulfide 0-50 ppm.
 - b. Sensor Accuracy: Linearity - +/- 2% full scale or 2ppm.
 - c. Repeatability - +/-1% full scale or 2ppm.
 - d. Drift: Zero – Less than 5%/year, typically; Span – Less than 10%/year, typically.

- e. Noise: Less than 1% full scale.
 - f. Response times: Less than 12 seconds (typically 6 seconds).
 - g. Power Input: 24 V DC @ 24 mA maximum.
 - h. Enclosure Type: 316 Stainless Steel, UL Approved, NPT Threads, with a minimum of 4 entries, allowing for flexible mounting option for sensor, power, signal and optional relay wiring.
 - i. Temperature Range: -40 ° C to +60 ° C (-40 ° F to + 140 ° F).
 - j. Sensor Humidity: 15-95 % Relative Humidity (non-condensing).
 - k. Sensor Electrical Rating: Class 1 Division 1 Groups A, B, C, D.
 - l. Sensor Enclosure: NEMA 7 (explosion proof).
 - m. Sensor Material: 316 Stainless Steel.
 - n. Sensor Mounting Style: Dual Condulet (Remote)
 - o. Calibration: The sensor shall be calibrated remotely using tubing going from transmitter display to the sensor.
 - p. Sensor Life/Warranty: 2 years typical with minimum 1 year warranty from manufacturer.
 - q. Sensor Guard: Provide for protection from moisture and dust.
 - r. Installation Hardware: Provide Mounting Kit as required for installation.
2. Transmitter:
- a. Transmitter Type: With integral display and capable of non-intrusive intrinsically safe calibration.
 - b. Transmitter electronics: one single PCB for increased reliability. The PCB shall offer expandability to allow up to 4 relays (do not provide relays).
 - c. Transmitter Power: 24 V DC supplied over 3-Wires current source.
 - d. Transmitter Output: 4-20 mA non- isolated linear; Isolated output non feasible with on-board relays and catalytic sensors.
 - e. Transmitter Display: 3 ½" Digit LCD; shall indicate power on, gas concentration, alarm and fault conditions. Visible from a minimum of 5 feet and shall be present at all times; Alternate between type and gas concentration End of sensor life, and sensor sensitivity display required.
 - f. Installation Hardware: Provide mounting kit as required for installation.
3. Sensor/Transmitter Approvals:
- a. UL 1203 & Factory Mutual (FM) - Class 1, Div. 1 & 2 Groups A, B, C, & D hazardous atmospheres.
 - b. Calibration: Detection system (sensor/transmitter) shall be factory calibrated. Manufacturer certified calibration required. Include calibration kit with gases and hand held remote control.
4. Tagging: 316 SS engraved tag for sensor and transmitter required. See contract drawings for locations of the sensors.
5. Hydrogen sulfide sensors shall be mounted near floor, with remote transmitter or integral as indicated on the drawings.
6. Mount at locations indicated on Drawings and as directed by the Engineer.
7. Provide Sample Pump for 24 VDC power operation and suitable for explosion proof area, for Hydrogen Sulfide gas detection near wet well area (also see Drawings). Include suitable NEMA 7 disconnect switch, flow switch and

mounting hardware for installation. Provide sample piping in accordance with specification section 40 05 31, Thermoplastic Process Pipe.

8. Accessories:
 - a. Interconnecting Cable – Provide in length required.
 - b. End of line filter to prevent water infiltration into sample line.
 - c. Flow Block Assembly to allow for calibration including flow cap. See mounting details on drawings.
9. Product and Manufacturer: Provide one of the following:
 - a. Ultima XE-16 for hydrogen sulfide detection, as manufactured by MSA.
 - b. Infiniti U9500B transmitter, with C7064E hydrogen sulfide sensor, as manufactured by Det-Tronics.
 - c. Or equal.

D. Oxygen System Required Features:

1. Sensor:
 - a. Sensor Detection: Electrochemical Oxygen(O₂) 0-25%
 - b. Sensor Accuracy: Linearity - +/- 10% full scale or 2ppm.
 - c. Repeatability - +/-1% full scale or 2ppm.
 - d. Drift: Zero – Less than 5%/year, typically; Span – Less than 10%/year, typically.
 - e. Noise: Less than 1% full scale.
 - f. Response Time: Less than 12 seconds (typically 6 seconds).
 - g. Power Input: 24 V DC @ 24 mA maximum.
 - h. Enclosure Type: Stainless Steel, UL Approved, NPT Threads, with a minimum of 4 entries, allowing for flexible mounting option for sensor, power, signal and optional relay wiring.
 - i. Temperature Range: -40 ° C to +40 ° C (-40 ° F to + 140 ° F).
 - j. Sensor Humidity: 15-95 % Relative Humidity (non-condensing).
 - k. Sensor Electrical Rating: Class 1 Division 1 Groups A, B, C, D.
 - l. Sensor Enclosure: NEMA 7 (explosion proof).
 - m. Sensor Material: 316 Stainless Steel.
 - n. Sensor Mounting Style: Dual Condulet.
 - o. Calibration: The sensor shall be calibrated without opening the enclosure by means of a non-intrusive intrinsically safe hand held wireless remote control.
 - p. Sensor Life/Warranty: 2 years typical with minimum 1 year warranty from manufacturer.
 - q. Sensor Guard: Provide for protection from moisture and dust.
 - r. Installation Hardware: Provide Mounting Kit as required for installation.
2. Transmitter:
 - a. Transmitter Type: With integral display and capable of non-intrusive intrinsically safe calibration.
 - b. Transmitter electronics: one single PCB for increased reliability. The PCB shall offer expandability to allow up to 4 relays (do not provide relays).
 - c. Transmitter Power: 24 V DC supplied over 3-Wires current source.

- d. Transmitter Output: 4-20 mA non- isolated linear; Isolated output non feasible with on-board relays and catalytic sensors.
 - e. Transmitter Display: 3 ½” Digit LCD; shall indicate power on, gas concentration, alarm and fault conditions. Visible from a minimum of 5 feet and shall be present at all times; Alternate between type and gas concentration End of sensor life, and sensor sensitivity display required.
 - f. Installation Hardware: Provide Mounting Kit as required for installation.
 - 3. Sensor/Transmitter Approvals:
 - a. UL 1203 & Factory Mutual (FM) - Class 1, Div. 1 & 2 Groups A, B, C, & D hazardous atmospheres.
 - 4. Calibration: Detection system (sensor/transmitter) shall be factory calibrated. Manufacturer certified calibration required. Include calibration kit with gases.
 - 5. Tagging: 316 SS engraved tag for sensor and transmitter required. See contract drawings for locations of the sensors.
 - 6. All oxygen sensors are integral with the transmitter and are mounted at locations indicated on Drawings and as directed by the Engineer.
 - 7. Product and Manufacturer: Provide one of the following:
 - a. Ultima XE-14 for oxygen detection, as manufactured by MSA.
 - b. Infiniti U9500B transmitter, with C7064E oxygen sensor, as manufactured by Det-Tronics.
 - c. Or equal.
- E. Local Alarm Devices:
- 1. Warning Light:
 - a. General: The light shall provide a visual warning in the area where a potential hazard may occur.
 - b. Required Features:
 - c. Strobe Light: Rotating 360 degrees; 520,000 candela power, 165 effective candlepower, 80 flashes per minute.
 - d. Lens Color: Amber.
 - e. Enclosure: NEMA 7; NEMA 4X; per area designation.
 - f. Power: 120 VAC.
 - g. Approvals: UL Listed for Class 1, Div. 1, Groups C & D.
 - h. Dimensions: 15.63” high and 8.82” diameter (explosion proof); 7.25” high and 5.5” diameter.
 - i. Provide manufacturer wall mounting hardware.
 - j. Quantity: 8
 - k. Products and Manufacturers: Provide one of the following:
 - 1) Model 27XST and Model 225, as manufactured by Federal Signal.
 - 2) Or equal.
 - 2. Safety Sign:
 - a. General: Provide safety signs for mounting next to each warning light, and at each entrance into the building and areas where gas is being monitored.
 - b. Required Features:
 - 1) Material: Rigid laminated plastic.

- 2) Sign Size: Minimum 7-inches wide by 12-inches high, 1/4-inch thick.
 - 3) Letter Size: Minimum 3-inches high.
 - 4) Color: Yellow background with black lettering.
 - 5) Engraving for all warning light locations:
 - "DANGER".
 - "GAS".
 - "EVACUATE"
 - "DO NOT ENTER"
 - c. Manufacturers: Provide products of one of the following:
 - 1) Controls Unlimited, Perry, Ohio.
 - 2) Or equal.
- 3. Horn:
 - a. General: The horn shall provide an audible warning in the area where a potential hazard may occur.
 - b. Required Features:
 - 1) Decibel Output: 100 at ten feet, minimum & 110 at one meter.
 - 2) Enclosure: Cast aluminum corrosion resistant housing.
 - 3) Horn Diaphragm: Stainless steel.
 - 4) Power: 120 VAC.
 - 5) Approvals: UL Listed for Class, Div. 1, Groups C & D for explosion proof areas, NEMA 7 rated.
 - 6) NEMA 4X for non-explosion proof areas.
 - 7) Quantity: 8
 - c. Products and Manufacturers: Provide one of the following:
 - 1) Model 31X (explosion proof) and Model 350 (non-explosion proof), as manufactured by Federal Signal.
 - 2) Or equal.
- E. Spare Parts: The following shall constitute the minimum spare parts for the equipment furnished.
 - 1. One Combustible gas sensor and transmitter. (One of each).
 - 2. One Hydrogen sulfide gas sensor and transmitter. (One of each).
 - 3. One Oxygen gas sensor integral with the transmitter. (One complete).

2.17 PROCESS CONTROL DESCRIPTIONS

- A. General:
 - 1. Process control function shall be structured to permit the realization of all control strategy requirements. In addition, each control function shall be designed so that smooth bumpless operation transfers are obtained during any operating mode changeover, initialization, and normal shutdown modes. Where applicable, user-changeable parameters shall be automatically defaulted to a preset value if a specific value is not given during system generation.
 - 2. The P&IDs represent requirements for process monitoring and control. The required control for the system is a combination of the representation on the P&IDs and the requirements specified herein. The P&IDs do not show all the

required point and/or internal diagnostic indications. In addition, to the indications shown on the P&IDs the following, at a minimum shall be provided:

- a. Indication and alarming of bad quality or “out of range” on any hard-wired analog input/output point (such as zero milliamps on a 4 to 20 mADC circuit).
 - b. Individual PLC fault indications and alarms (at the processor, I/O card, and module levels).
 - c. Indication and alarm of a communications failure for each fiber optic, Ethernet, or field network communication link. For redundant links provide indication and alarm for both links so that an operator will be notified if the link has lost redundancy.
 - d. For all motor start and stop commands check for run feedback after adjustable time delay (0 to 30 seconds). Provide a “FAIL TO START” and “FAIL TO STOP” alarm if unit fails to run or stop. Use the bad start or stop bit to remove the run command from the control logic.
 - e. For all open/close valves provide Fail to Open, Fail to Close.
 - f. For all modulating valves, provide “fail to open to commanded setpoint” and “fail to close to commanded setpoint.”
 - g. For analog control loops, when control of field equipment is not in “REMOTE/AUTO,” the associated PID controller output shall track the position feedback, and eliminate windup, for bumpless transfer or entry to REMOTE/AUTO mode.
 - h. RUNTIMES for all electric motors shall be provided with no manual reset button at the OIT. It shall be able to accumulate up to 999,999 and then go back to zero. Runtimes values shall be saved in the PLC even under power failures.
 - i. FLOW TOTALIZATION shall be provided for each flow signal. Provide lifetime flow total, daily flow total, and previous day flow total for all flow signals.
 - j. For all analog signals, provide the following alarm indications:
 - 1) “HIGH-HIGH.”
 - 2) “HIGH.”
 - 3) “LOW.”
 - 4) “LOW-LOW.”
 - 5) “HIGH AND LOW RATE OF CHANGE.”
3. In addition to the indications shown on the P&IDs, the following shall be provided at a minimum:
- a. Analog Data Scaling: This control function shall scale all analog inputs to a common span and shall normalize the digital representation of each analog input to a percent of the operating span. The processed value shall be expressed as a binary number that specifies the analog input's position on a straight line lying between zero and full scale as defined for a given input by the zero span values in the data base.
 - b. Amplitude Limit Check: This control function shall perform dual level, high/low amplitude limit checking and shall identify a limit violation every time a measured or virtual variable goes out-of-limits and returns back into limits. The control function shall determine the time at which

each limit excursion occurred. A deadband shall be provided on each limit and shall be expressed as a percentage of span or in engineering units. Low and high limiting default values shall be set-up for each measured or calculated variables used in the process control loops.

- c. Engineering Unit Conversion: This control function shall convert scaled analog data to engineering units by means of the following equation:

$$Y = (H - L) (D/DH) + L$$

where:

- Y = Value in engineering units.
- H = High value of span, expressed in engineering units.
- L = Low value of span, expressed in engineering units.
- D = Digitized scaled input value in counts.
- DH = Full scale digitized value in counts.

- d. Verification of Digital Outputs: This control function shall verify that the equipment has responded to the digital commands before proceeding to next step during automatic operation. If any discrepancy is detected, an alarm shall be annunciated.
- 4. Hardware: CONTRACTOR shall provide all the hardware, as shown, specified or required to implement the control strategies as described.
 - 5. Configuration: All set points, tuning parameters and engineering scales etc. shall be documented for each control point and each control strategy on configuration sheets or similar documents. These documents shall be updated during Factory Testing and finally during start-up.
 - 6. Plant Power Failure: Plant equipment controlled by the control system shall be programmed to automatically reset upon failure, and unless otherwise specified, restart in the mode previous to the power failure. Requiring the manual reset of equipment after a power failure, unless otherwise specified, is unacceptable. All equipment shall restart in an orderly fashion or sequence approved by the ENGINEER.
 - 7. All relays, parameters, scales, configuration values, mathematical constants, equations and set points given in the control strategies shall be adjustable over a defined range. Values given are initial and may change during Shop Drawing review and may have to be readjusted during start-up. All initial values, settings, and setpoints shall be enterable between +/- 50% of value provided. If a value outside of this range is entered, the system shall provide an "invalid entry" message and reject the entry.
 - 8. OIT screens shall be developed in accordance to the requirements as described herein.

B. Control Strategy and OIT Graphic Workshops:

- 1. Provide time for a minimum of two (2), 1-hour on-site workshops with Owner and Engineer staff to review and provide detailed input to the control narratives and system graphics. Revise control setpoints, adjustment ranges, ad default values, logic capabilities and system graphics as required. Provide

as many off-site conference calls, WebEx's, or workshops as required to fully meet strategy and graphic requirements.

2. Items discussed at these workshops shall be incorporated into the OIT configuration at no additional cost to the OWNER.

C. Alarms and Events:

1. All alarms shall annunciate on the alarm banner and have corresponding indication on associated graphics screen.
2. Alarm acknowledgment shall be synchronized across the process control network so only one acknowledge is required.
3. Up to sixteen high priority alarms shall be sent from the PLC to the existing Mission control system.

D. Trending:

1. Trending shall be available for all mode and status selections.
2. Configure trends for all analog values, including derived analog values in the program (e.g. PID setpoint, PID output, interim holding registers, etc.)
3. All trend screens shall be of a similar format.
4. As examples of grouping of analog values, provide multi-pen pre-configured trend screens for the following:
 - a. Pumping system:
 - 1) Effluent Flow
 - 2) Wet Well Level (active)
 - 3) Wet Well Level Setpoint
 - 4) Pump #1 Speed, Pump #2 Speed, Pump #3 Speed and Pump #4 Speed
 - b. Trends shall have logical groupings by system, with appropriate scaling for visibility. For example:
 - 1) Gas monitoring: O₂, H₂S, and combustible for both wells
 - 2) Influent and Effluent Flow.
 - 3) Pumps run status (on/off)
 - 4) Group other analog signals as shown on P&IDs in a similar fashion.

D. Active Level Control Strategy:

1. One level transmitter will be installed in each wet well for a total of three.
2. The level measurement used for control (Called active wet well level) will be determined as follows:
 - a. The operator may select on the OIT which level transmitter is the active one. Either wet well #1, #2, #3 or average of all of them.
 - b. The operator may select on the OIT which level transmitters are "Out of Service" if they know the instrument is not working properly or it is known that the respective well is out of service. A level transmitter out of service shall generate an alarm.
 - c. If the selected level transmitter (active) signal becomes invalid (less than 4mA or greater than 20mA after a time delay), transfer active status to the next transmitter. The transfer cannot occur to any disabled level transmitter.

- d. When “Average” is selected as the active level, the PLC shall average the level measurement of all active level transmitters. A level transmitter that has been selected as “Out of Service” will not be included in the average.
 - 1) If the level readings of any of the level transmitters that are part of the average calculation diverge by 15% or more, an alarm shall be generated.
 - 2) If any of the level transmitter signals becomes invalid (less than 4mA or greater than 20mA after a time delay), remove it from the average calculation and the system shall turn it into out of service.

E. Pump System Control Strategy

- 1. Overview: The pump station has two Low capacity pumps and two high capacity pumps. Each low capacity pump can handle up to 3.0 MGD and both together up to 5.9 MGD. The low capacity pumps shall run in a lead/lag mode. These pumps are designed for dry weather or average flow operations. Each high capacity pump is sized for 10.5 MGD. These pumps are designed for wet weather and shall operate in a duty/standby mode. When the High capacity pumps are required, the low capacity shall be shut off. Bumpless transfer shall be required to minimize the hammer effect in the force main. The pumps shall operate based on water level as monitored by the level transmitters. They will be controlled to maintain the water level constant by using a PID control loop.
- 2. The pump’s motor protection device is hardwired to the electric motor so that it is always active. Trip of the device for high motor or bearing temperature, moisture detection or high vibration shall shutdown the pump and prevent it from starting until cleared. These signals shall provide Fault indication at the OIT.
- 3. The pump operation shall be controlled by the PLC as described below. An Emergency Stop (E-Stop) push button shall be provided near the respective pumps, which will shut down the pump when pressed.
- 4. Normal Operation:
 - a. The pump station can be operated in two modes: MANUAL and AUTOMATIC. Normal operation shall be in AUTOMATIC.
 - b. Manual Operation:
 - 1) When the system is in manual mode (operator selectable), each pump can be operated manually by placing the respective pump selector switch in MANUAL position on the Pump Control Screen.
 - 2) Once the MANUAL position is activated, the operator shall be allowed to enter the pump speed desired. Then, the pump can be run by depressing the “Start” pushbutton on the Pump Control Screen. While the pump is running, the operator shall be able to change the speed at any time.
 - 3) The pump shall stop by depressing the “Stop” pushbutton on the Pump Control Screen.
 - 4) In the manual mode, all interlocks shall remain operational and shall shutdown the associated pump
 - c. Automatic Operation:

- 1) If the active level in the wet well reaches the “Lead Low Capacity Pump Start level” setpoint and after a time delay, the lead low capacity pump shall be called to run. Then, the lead low capacity pump shall ramp up its speed to try to attain the “Target Level” setpoint.
- 2) If the lead low capacity pump reaches full speed and the active level continues to rise and reaches the “Lag Low Capacity Pump Start Level” setpoint after a field-adjustable time delay, the lag low capacity pump shall be called to run.
- 3) The lead low capacity pump shall ramp down its speed while the lag low capacity pump ramps up until both pumps match speeds at the “mid-point Level” setpoint for a field-adjustable time delay (initial 2 seconds). Then both pumps will ramp up speed in tandem to try to attain the “Target Level” setpoint.
- 4) If the active level begins to drop and reaches the “Lag Low Capacity Pump Stop Level” setpoint after a field-adjustable time delay, the lag low capacity pump shall be called to shut off.
- 5) If the active level continues to drop and reaches the “Lead Low Capacity Pump Stop Level” setpoint after a field-adjustable time delay, the lead low capacity pump shall be called to shut off.
- 6) If one or both low capacity pumps are running and the active level in the wet well continues to rise so it reaches the “Duty High Capacity Pump Start Level” after a field-adjustable time delay, the duty high capacity pump shall be called to run.
- 7) All running low capacity pumps shall ramp down their speed while the high capacity pump ramps up until all pumps match speeds at the “mid-point” setpoint for a field-adjustable time delay (initial 2 seconds). Then all running low capacity pump shall be called to shut off while the high capacity pump ramps up speed to try to attain the “Target Level” setpoint.
- 8) If the active level begins to drop and reaches the “High Capacity Pump Stop Level” setpoint after a field-adjustable time delay, the High Capacity Pump shall be called to shut off.

d. The following is the list of the initial field-adjustable level setpoints. Setpoints are provided in elevation but shall be converted by CONTRACTOR to level in the wet well based on the final location of the level transmitters. These setpoints may change during commissioning based on operational data.

1) Wet Well High Level:	65.5
2) Duty High Capacity Pump Start level:	62.8
3) Lag Low Capacity Pump Start level:	62.4
4) Lead Low Capacity Pump Start level:	62.0
5) Target Level:	61.5
6) Duty High Capacity Pump Stop level:	60.7
7) Lag Low Capacity Pump Stop level:	61.0
8) Lead Low Capacity Pump Stop level:	60.5
9) Wet Well Low Level:	60.0

5. Automatic pump alternation:

- a. The two high capacity pumps shall operate in a duty/standby mode with only one pump running at a time.
 - b. The MCP shall automatically alternate the duty pump based on a manual soft selector switch (Pump 1/Pump 4/Alternate) which shall be accessible via the OIT.
 - 1) Pump 1 - Will be assigned as “duty” pump.
 - 2) Pump 4 - Will be assigned as “duty” pump.
 - 3) Alternate - The role of “duty” pump shall alternate every time the pump is called to run.
 - c. The two low capacity pumps shall operate in a lead/lag mode.
 - d. The MCP shall automatically alternate the lead pump based on a manual soft selector switch (Pump 2/Pump 3/Alternate) which shall be accessible via the OIT.
 - 1) Pump 2 - Will be assigned as “lead” pump.
 - 2) Pump 3 - Will be assigned as “lead” pump.
 - 3) Alternate - The role of “lead” pump shall alternate based on
 - a) Every time the pump is called to run.
 - b) Runtime hours.
6. High Capacity Pump Exercise Mode. The station shall have a High Capacity Pump Exercise mode. This mode will occur automatically based on an adjustable schedule. It shall also be possible for the operator to manually initiate or disable this mode. While in this Mode, the Wet Well shall fill to the high level alarm point. At this point, one High Capacity Pump shall be turned on at Minimum Speed (operator adjustable) and run to draw down the Wet Well until the low level is reached. This operation shall be repeated with the second High Capacity Pump. After the final drawdown, the High Capacity Pump Exercise shall be completed, and the control system shall exit the Exercise Mode and the Station shall return to Normal Auto operation. The frequency of Cycle occurrence (i.e. daily, weekly, monthly) shall be field programmable. The Cycle shall be on a timer such that if the Cycle is not completed in 60 minutes, the cycle shall automatically stop and return to Normal Auto Mode.

E. Power Monitoring Device

1. Provide Power Monitoring with following signals to PLC via RS-485, Modbus RTU Protocol:

a. Volts:	0.2% Accuracy
b. Amperes:	0.2% Accuracy
c. Watts, Vars and VA:	0.5% Accuracy
d. Power Factor:	1% Accuracy
e. Frequency:	0.05% Accuracy
f. Watt, and VA Hours:	0.5% Accuracy
g. Var Hours:	1% Accuracy
h. Watt, Var and VA Demand:	0.4% Accuracy
i. THD-Voltage:	50 th Harmonic
j. THD-Current:	50 th Harmonic
k. Individual Ampere Harmonics:	50 th Harmonic
l. Individual Voltage Harmonics:	50 th Harmonic

2. All signals from Power Monitoring Device shall be displayed on Main Control Panel OIT.
- F. Motor Protection Relay
1. Provide Pump Motor Monitoring with following signals to PLC via Modbus TCP/IP Ethernet Protocol:
 - a. Motor Winding Temperature
 - b. Stator Temperature
 - c. Thrust Bearing Temperature
 - d. Water Intrusion Within The Motor Stator Chamber
 - e. Water Intrusion In The Pump Power Cable Junction Chamber
 - f. Upper Support Bearing Temperature
 - g. Vibration
 2. All signals from Motor Protection Relay shall be displayed on Main Control Panel OIT.

2.20 SOURCE QUALITY CONTROL

- A. General:
1. Factory Test:
 - a. "CONTRACTOR shall include in the lump sum all costs required for 4 persons, between OWNER representatives and ENGINEER to witness factory tests at manufacturer's testing facility. Costs, including travel, lodging, meals and incidentals, for witness testing visits shall be at no additional cost to OWNER. Provide a minimum of 30 days advance notice to ENGINEER prior to the proposed testing dates so that arrangements for test witnessing can be made. Presence of OWNER and ENGINEER during testing does not relieve the CONTRACTOR from complying with the Contract Documents and shall not imply acceptance of equipment.
 - b. Shop witness tests shall be scheduled so as to minimize the number of individual, separate trips to the manufacturer's testing facility. Scheduling of testing shall not require any overnight stays on Friday , Saturday, or Sunday nights.
 2. Professional Engineer:
 - a. Engage a registered professional engineer legally qualified to practice and experienced in providing the engineering services of the kind indicated. Professional engineer may be an employee of manufacturer.
 - b. Submit qualifications data.
 - c. Responsibilities include but are not necessarily limited to:
 - 1) Preparing or supervising the preparation of shop test set ups.
 - 2) Performing or supervising the performance of shop tests, interpretation and engineering analysis of shop test data, and preparation of test reports.
 - 3) Certifying that the tests performed and results achieved conform to the Contract Documents.

- d. When factory tests have been successfully completed, submit to ENGINEER factory test report signed and sealed by professional engineer.
3. Factory test results will be acceptable when all components within tested control panel or system being tested successfully operate and meet its intended function, and are so certified by the testing entity.
4. Do not ship the equipment until obtaining ENGINEER's acceptance of factory test results.

B. Factory Inspection:

1. Inspect each panel, console, device, and cabinet before testing and before shipping. Inspection shall include, but not be limited to the following:
 - a. Verify all "Approved as Corrected" comments on Shop Drawings were implemented.
 - b. Verify presence of and accuracy of nameplates and tags.
 - c. Verify that wire sizes and color-coding comply with the Contract Documents.
 - d. Verify presence of terminal blocks, terminal block numbers, and required quantity of spares.
 - e. Verify annunciator window engravings and quantity of spare windows comply with the Contract Documents.
 - f. Verify proper wiring practices and grounding.
 - g. Verify enclosure flatness, finish, and color.
 - h. Verify anchoring of wire bundles between subpanels and front panel-mounted devices.
 - i. Verify presence of applicable items specified in this Section.
 - j. Check and verify software licenses for latest release and license types.

C. Operational Testing:

1. Test all input/output components to verify that internal panel wiring is properly terminated at correct locations. Verify initial ranges and settings.
2. Test all system hardware and software to verify proper operation as stand-alone units. Test shall include, but not be limited to, the following:
 - a. Power distribution and breaker ratings to match approved Shop Drawings.
 - b. Power fail/restart tests.
 - c. Diagnostics checks.
 - d. Demonstrate that all specified equipment functional capabilities are working properly.
 - e. Check and verify process displays are in accordance with approved Shop Drawings.
3. Test components and devices requiring data transmission to verify that communication between such components is working properly. Verify communication by using the same media required for the completed system at the Site as indicated in the Contract Documents.
4. Perform integrated system test with MCP and OIT. Simulate inputs/outputs to verify that equipment is performing properly as an integrated system.
5. Simulation devices shall be of suitable quality to not mask control panel defects.

PART 3 – EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the Work is to be installed and notify the ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Environmental Requirements:
 - 1. No instrument shall be scheduled to be installed in an area where active construction can cause it to be damaged, unless CONTRACTOR provides adequate protection for said instrument.
 - 2. Miscellaneous hardware such as fittings, fasteners, screws, etc., shall be of Type 316 stainless steel and shall be suitable for the service intended. Pipe stands shall be provided for fastening of instruments, as required. They shall be pipe threaded with flange bolted to slab. Use carbon steel piping and flanges with epoxy painting conforming to the requirements of Section 09900, Painting.
- B. Installation of Instrumentation:
 - 1. Field mounted instruments shall be secured to stands or brackets in accordance with the manufacturer's recommendations and the approved Shop Drawings:
 - 2. Sensors shall be located generally where shown. Exact locations shall be confirmed in the field.
 - 3. All devices shall be installed such that they are readily accessible for service and do not cause potential tripping hazards.
- C. Material of Construction:
 - 1. All cable, conduits, stands, supports and appurtenances shall be in accordance with manufacturer's recommendations, approved Shop Drawings and as shown.
- D. System Checkout:
 - 1. CONTRACTOR shall furnish the following documentation to the OWNER and ENGINEER as proof of readiness to begin checkout.
 - a. Completed calibration sheets for each installed instrument showing three point calibration, signed by a factory authorized serviceman.
 - 2. CONTRACTOR shall give written notification to the OWNER and ENGINEER 14 days in advance of his readiness to begin system checkout and shall schedule system checkout on dates agreed on by the OWNER and ENGINEER.
 - 3. CONTRACTOR shall have a written procedure for checkout. This written procedure shall be submitted to the OWNER and ENGINEER for approval

three months prior to the beginning of checkout. CONTRACTOR shall submit for approval a written procedure for commissioning to the OWNER and ENGINEER at the same time.

4. At the system checkout, CONTRACTOR shall have:
 - a. Completed Paragraph 3.2.D.1., above.
 - b. Test instruments, as required.
5. It shall be CONTRACTOR'S responsibility to record the results of systems checkout, effect whatever remedial action is required and arrange for re-inspection to review said remedial action, at no additional cost to the OWNER.
6. The completion of the above does not relieve CONTRACTOR from guarantees specified elsewhere in this Section.

E. Services and Operator Instructions:

1. CONTRACTOR shall furnish all repairs or replacement of defective materials, equipment or workmanship, including with respect to equipment, the services of factory-trained servicemen.
2. CONTRACTOR shall furnish, as part of this Contract, a one-year service contract covering parts and labor for the complete system. Service contract shall be with nearest "Authorized dealer/service representative" for on-Site service.
3. In addition to the calibration required for checkout, provide two additional calibrations on all instruments. The first re-calibration shall be approximately six months after acceptance of the system, and the second shall be approximately eleven months after acceptance. As part of each calibration, provide two copies of the calibration sheets, a detailed list of deficiencies (should any be found), and a statement that the entire system is in proper operation and condition (except for the deficiencies noted) and shall be turned over to the OWNER.

3.3 CALIBRATION, START-UP AND TESTING

A. Field verify the calibration and performance of each instrument prior to start-up of the associated equipment, and document on a separate sheet for each.

1. For each calibration certification sheet, include the following information:
 - a. Project name.
 - b. Tag number and description.
 - c. Manufacturer.
 - d. Model and serial number.
 - e. Date, time and person who performed calibration.
 - f. Calibration data to include.
 - 1) Input, output, and error at 0, 25, 75, and 100 percent of span for analog instruments.
 - 2) Switch setting, contact action and deadband, if applicable, for discrete elements.
 - g. Space for comments.
 - h. Space for sign off and date.
2. System Check-Out and Start-Up Responsibilities:

- a. CONTRACTOR shall retain the services of the System Supplier to supervise and/or perform check-out and start-up of all system components. As part of these services, the System Supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.
- b. Check and approve the installation of all instrumentation and control system components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
- c. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in the Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
- d. CONTRACTOR shall provide all test equipment necessary to perform the testing during system checkout and start-up.
- e. CONTRACTOR and System Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustment or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended.
- f. CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and panel mounted devices specified in this Section as soon as calibration is completed.
- g. CONTRACTOR shall furnish ENGINEER an Installation Inspection Report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the System Supplier.
- h. Instrumentation and Control System Field Test:
 - 1) Following the instrumentation and control system checkout and initial operation, CONTRACTOR, under the supervision of the System Supplier, shall notify the Engineer and Owner and perform a complete witnessed system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended instrumentation and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.
 - 2) Following demonstration of all system functions, the instrumentation and control system, including field sensors/transducers and instruments, and telemetry system shall be running and fully operational for a continuous 48 hour period.

3.4 INSTRUMENTATION AND CONTROL SYSTEM TRAINING

A. General:

1. CONTRACTOR shall retain the services of the System Supplier to provide operation and maintenance training for all instrumentation and control system equipment as specified herein.
2. For equipment items not manufactured by the System Supplier, he shall provide for on-Site training by an authorized representative of the equipment manufacturer as part of his services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
3. CONTRACTOR shall be responsible for all costs associated with training and shall provide all required materials, texts and required supplies.
4. Training shall conform to the requirements of Section 01821, Instruction of Operations and Maintenance Personnel.

B. On-Site Training:

1. Primary Sensors/Transducers and Field Instruments:
 - a. Provide on-Site operation and maintenance training by System Supplier and the equipment manufacturer representatives prior to placing the equipment in continuous operation. The services of equipment manufacturer's representatives shall be provided for a minimum of 4 hours for each type of instrument.
2. Training shall accomplish the following:
 - a. Provide instruction covering use and operation of the equipment to perform the intended functions.
 - b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.
 - c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.
- d. Provide classes and field training as to how to change process control and alarm set points in all microprocessor based controllers and transmitters. Maintenance personnel shall be trained to enter passwords, programming or configuration data, etc.

+ + END OF SECTION + +

INPUT-OUTPUT LIST

				TAG	DESCRIPTION	SIGNAL TYPE	HARD WIRED I/O		DRAWING
							SIGNAL FROM	SIGNAL TO	
AI	001	1		AI-001	Wet Well Hydrogen Sulfide Gas Measurement	AI	AIT-001	MCP	I-2
FL	001	2		FL-001	Wet Well Hydrogen Sulfide Sampling Pump Low Flow Alarm	DI	FSL-001	MCP	I-2
YA	001	5		YA-001	Wet Well Gas Monitoring Horn Circuit	DO	MCP	Horn	I-2
AI	002	3		AI-002	Wet Well Combustible Gas Measurement	AI	AIT-002	MCP	I-2
YA	002	6		YA-002	Wet Well Gas Monitoring Strobe Circuit	DO	MCP	Strobe Light	I-2
AI	003	4		AI-003	Wet Well Oxygen Gas Measurement	AI	AIT-003	MCP	I-2
AI	004	9		AI-004	Dry Well Hydrogen Sulfide Gas Measurement	AI	AIT-004	MCP	I-2
YA	004	12		YA-004	Dry Well Gas Monitoring Horn Circuit	DO	MCP	Horn	I-2
AI	005	10		AI-005	Dry Well Combustible Gas Measurement	DI	AIT-005	MCP	I-2
YA	005	13		YA-005	Dry Well Gas Monitoring Strobe Circuit	DO	MCP	Strobe Light	I-2
AI	006	11		AI-006	Dry Well Oxygen Gas Measurement	DI	AIT-006	MCP	I-2
LH	007	18		LH-007	Clogged Bar Screen - Upstream Level High	DI	LSH-007	MCP	I-2
YI	008	19		YI-008	Grinder No. 1 Running	DI	Grinder No. 1 CP	MCP	I-2
ZC	009	20		ZC-009	Grinder No. 1 E-Stop	DI	Grinder No. 1 CP	MCP	I-2
YA	011	22		YA-011	Grinder No. 1 Malfunction	DI	Grinder No. 1 CP	MCP	I-2
YI	012	23		YI-012	Grinder No. 2 Running	DI	Grinder No. 2 CP	MCP	I-2
ZC	013	24		ZC-013	Grinder No. 2 E-Stop	DI	Grinder No. 2 CP	MCP	I-2
YA	015	26		YA-015	Grinder No. 2 Malfunction	DI	Grinder No. 2 CP	MCP	I-2
LH	016	27		LH-016	Wet Well No. 1 Level High	DI	LSH-016	MCP	I-2
YA	016	36		YA-016	Common Alarm	DO	MCP	Level Monitoring Panel	I-2
LH	017	28		LH-017	Wet Well No. 2 Level High	DI	LSH-017	MCP	I-2
LH	018	29		LH-018	Wet Well No. 3 Level High	DI	LSH-018	MCP	I-2
L	019	30		L-019	Wet Well No. 1 Level	AI	LT-019	MCP	I-2
LI	019	33		LI-019	Wet Well No. 1 Level Indication	AO	MCP	Level Monitoring Panel	I-2
L	020	31		L-020	Wet Well No. 2 Level	AI	LT-020	MCP	I-2
LI	020	34		LI-020	Wet Well No. 2 Level Indication	AO	MCP	Level Monitoring Panel	I-2
L	021	32		L-021	Wet Well No. 3 Level	AI	LT-021	MCP	I-2
LI	021	35		LI-021	Wet Well No. 3 Level Indication	AO	MCP	Level Monitoring Panel	I-2
LH	022A	37		LH-022A	Dry Well Flood Monitor	DI	LSH-022	MCP	I-2
YI	024	38		YI-024	Pump No. 1 (High Capacity) Running	DI	MCC	MCP	I-2
YA	025	39		YA-025	Pump No. 1 (High Capacity) Level A Alarm Critical	DI	MCC	MCP	I-2
YA	026	40		YA-026	Pump No. 1 (High Capacity) Level B Alarm Warning	DI	MCC	MCP	I-2
ZC	027	41		ZC-027	Pump No. 1 (High Capacity) E-Stop	DI	MCC	MCP	I-2
S	028	42		S-028	Pump No. 1 (High Capacity) Speed Feedback	AI	MCC	MCP	I-2
SC	029	43		SC-029	Pump No. 1 (High Capacity) Speed Command	AO	MCP	MCC	I-2
YA	030	44		YA-030	Pump No. 1 (High Capacity) Malfunction	DI	MCC	MCP	I-2
ZC	031	45		ZC-031	Pump No. 1 (High Capacity) Start/Stop Command	DO	MCP	MCC	I-2
FL	032	46		FL-032	Pump No. 1 (High Capacity) Low Flow	DI	MCC	MCP	I-2
YI	036	47		YI-036	Pump No. 2 (Low Capacity) Running	DI	MCC	MCP	I-2
YA	037	48		YA-037	Pump No. 2 (Low Capacity) Moisture Leak Detection	DI	MCC	MCP	I-2
YA	038	49		YA-038	Pump No. 2 (Low Capacity) Thermal Overload	DI	MCC	MCP	I-2
ZC	039	50		ZC-039	Pump No. 2 (Low Capacity) E-Stop	DI	MCC	MCP	I-2
S	040	51		S-040	Pump No. 2 (Low Capacity) Speed Feedback	AI	MCC	MCP	I-2
SC	041	52		SC-041	Pump No. 2 (Low Capacity) Speed Command	AO	MCP	MCC	I-2
YA	042	53		YA-042	Pump No. 2 (Low Capacity) Malfunction	DI	MCC	MCP	I-2
ZC	043	54		ZC-043	Pump No. 2 (Low Capacity) Start/Stop Command	DO	MCP	MCC	I-2
FL	044	55		FL-044	Pump No. 2 (Low Capacity) Low Flow	DI	MCC	MCP	I-2
YI	048	56		YI-048	Pump No. 3 (Low Capacity) Running	DI	MCC	MCP	I-2
YA	049	57		YA-049	Pump No. 3 (Low Capacity) Moisture Leak Detection	DI	MCC	MCP	I-2
YA	050	58		YA-050	Pump No. 3 (Low Capacity) Thermal Overload	DI	MCC	MCP	I-2
ZC	051	59		ZC-051	Pump No. 3 (Low Capacity) E-Stop	DI	MCC	MCP	I-2
S	052	60		S-052	Pump No. 3 (Low Capacity) Speed Feedback	AI	MCC	MCP	I-2
SC	053	61		SC-053	Pump No. 3 (Low Capacity) Speed Command	AO	MCP	MCC	I-2
YA	054	62		YA-054	Pump No. 3 (Low Capacity) Malfunction	DI	MCC	MCP	I-2
ZC	055	63		ZC-055	Pump No. 3 (Low Capacity) Start/Stop Command	DO	MCP	MCC	I-2
FL	056	64		FL-056	Pump No. 3 (Low Capacity) Low Flow	DI	MCC	MCP	I-2
YI	060	65		YI-060	Pump No. 4 (High Capacity) Running	DI	MCC	MCP	I-2
YA	061	66		YA-061	Pump No. 4 (High Capacity) Level A Alarm Critical	DI	MCC	MCP	I-2
YA	062	67		YA-062	Pump No. 4 (High Capacity) Level B Alarm Warning	DI	MCC	MCP	I-2
ZC	063	68		ZC-063	Pump No. 4 (High Capacity) E-Stop	DI	MCC	MCP	I-2
S	064	69		S-064	Pump No. 4 (High Capacity) Speed Feedback	AI	MCC	MCP	I-2
SC	065	70		SC-065	Pump No. 4 (High Capacity) Speed Command	AO	MCP	MCC	I-2

INPUT-OUTPUT LIST

			TAG	DESCRIPTION	SIGNAL TYPE	HARD WIRED I/O		DRAWING
						SIGNAL FROM	SIGNAL TO	
YA	066	71	YA-066	Pump No. 4 (High Capacity) Malfunction	DI	MCC	MCP	I-2
ZC	067	72	ZC-067	Pump No. 4 (High Capacity) Start/Stop Command	DO	MCP	MCC	I-2
FL	068	73	FL-068	Pump No. 4 (High Capacity) Low Flow	DI	MCC	MCP	I-2
PI	075A	74	PI-075A	Effluent Pressure	AI	PIT-075	MCP	I-2
FI	076A	75	FI-076A	Effluent Flow	AI	FIT-076	MCP	I-2
TL	077A	76	TL-077A	Low Temperature Switch	DI	TSL-077	MCP	I-2
ZA	078A	77	ZA-078A	Standby Power Transfer Switch Set To Generator	DI	ATS	MCP	I-2
EA	079A	78	EA-079A	Utility Power Failure	DI	ATS	MCP	I-2
EA	080A	79	EA-080A	Transfer Switch Simulated Power Failure	DI	ATS	MCP	I-2
YA	081A	80	YA-081A	Generator Run	DI	Generator	MCP	I-2
LA	082A	81	LA-082A	Generator Fuel Level Low	DI	Generator	MCP	I-2
YA	083A	82	YA-083A	Generator Failure	DI	Generator	MCP	I-2
YA	084	83	YA-084	Generator Common Alarm	DI	Generator	MCP	I-2
YA	085A	84	YA-085A	Ventilation Fan Off	DI	HMCS Panel	MCP	I-2
AI	086	85	AI-086	Odor Control Room Hydrogen Sulfide Gas Measurement	AI	AIT-086	MCP	I-2
YA	086	14	YA-086	Odor Control Room Gas Monitoring Horn Circuit	DO	MCP	Horn	I-2
AI	087	86	AI-087	Odor Control Room Combustible Gas Measurement	AI	AIT-087	MCP	I-2
YA	087	15	YA-087	Odor Control Room Gas Monitoring Strobe Circuit	DO	MCP	Strobe Light	I-2
AI	088	87	AI-088	Odor Control Room Oxygen Gas Measurement	AI	AIT-088	MCP	I-2
YA	096	16	YA-096	HMCS Panel Common Alarm	DI	HMCS Panel	MCP	I-2
LH	097	16	LH-097	Sump Pump Water Level High	DI	LSH-097	MCP	I-2

INSTRUMENTATION INDEX

ITEM	Tag	Description	Range/ (Setpoint)	Spec. Ref.	Remarks	Drawing No.
1	AE/AIT-001	Wet Well Hydrogen Sulfide Sensor/Transmitter				I-2
2	AE/AIT-002	Wet Well Combustible Gas Sensor/Transmitter				I-2
3	AE/AIT-003	Wet Well Oxygen Sensor/Transmitter				I-2
4	AE/AIT-004	Dry Well Hydrogen Sulfide Sensor/Transmitter				I-2
5	AE/AIT-005	Dry Well Combustible Gas Sensor/Transmitter				I-2
6	AE/AIT-006	Dry Well Oxygen Sensor/Transmitter				I-2
7	AE/AIT-086	Odor Control Room Hydrogen Sulfide Sensor/Transmitter				I-2
8	AE/AIT-087	Odor Control Room Combustible Gas Sensor/Transmitter				I-2
9	AE/AIT-088	Odor Control Room Oxygen Sensor/Transmitter				I-2
10	LSH-007	Influent Level Switch				I-2
11	LSH-016	Wet Well No. 1 Level Switch				I-2
12	LSH-017	Wet Well No. 2 Level Switch				I-2
13	LSH-018	Wet Well No. 3 Level Switch				I-2
14	LT-019	Wet Well No. 1 Level Transmitter				I-2
15	LT-020	Wet Well No. 2 Level Transmitter				I-2
16	LT-021	Wet Well No. 3 Level Transmitter				I-2
17	LI-019	Wet Well No. 1 Level Indicator				I-2
18	LI-020	Wet Well No. 2 Level Indicator				I-2
19	LI-021	Wet Well No. 3 Level Indicator				I-2
20	LSH-022	Dry Well Flood Monitor Level Switch				I-2
21	FSL-032	Dry Pit Submersible Pump No. 1 Discharge Flow Switch				I-2
22	FSL-044	Dry Pit Submersible Pump No. 2 Discharge Flow Switch				I-2
23	FSL-056	Dry Pit Submersible Pump No. 3 Discharge Flow Switch				I-2
24	FSL-068	Dry Pit Submersible Pump No. 4 Discharge Flow Switch				I-2
25	PI-071	Dry Pit Submersible Pump No. 1 Discharge Pressure Gauge				I-2
26	PI-072	Dry Pit Submersible Pump No. 2 Discharge Pressure Gauge				I-2
27	PI-073	Dry Pit Submersible Pump No. 3 Discharge Pressure Gauge				I-2
28	PI-074	Dry Pit Submersible Pump No. 4 Discharge Pressure Gauge				I-2
29	PIT-075	Effluent Pressure Transmitter				I-2
30	FE/FIT-076	Effluent Discharge Flow Meter				I-2
31	TSL-077	Temperature Monitoring Switch				I-2
32	LSH-097	Sump Pump Level Switch				I-3

++END OF SECTION++

++ NO TEXT ON THIS PAGE ++

SECTION 41 22 23

HOISTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install hoist systems complete and operational.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before hoist systems Work.

C. Related Sections:

1. Section 05 12 00, Structural Steel Framing.
2. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/AGMA 6013-A, Standard for Industrial Enclosed Gear Drives.
2. ANSI MH 27.1, Specifications for Underhung Cranes and Monorail Systems.
3. AISC Specification for Structural Steel Buildings.
4. ASME B30.16, Overhead Hoists (Underhung).
5. ASME HST-1, Performance Standard for Electric Chain Hoists.
6. ASME HST-2, Performance Standard For Hand Chain Manually Operated Chain Hoists.
7. ASME HST-4, Performance Standard for Overhead Electric Wire Rope Hoists.
8. AWS D1.1, Structural Welding Code – Steel.
9. AWS D14.1, Specification for Welding of Industrial and Mill Cranes and other Material Handling Equipment.
10. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Minimum of five years of experience producing substantially similar equipment and able to provide documentation of at least five installations in satisfactory operation for at least five years in the United States.
 - b. Equipment shall be manufactured in the United States.
2. Installer Qualifications:

- a. Engage an experienced installer to perform the Work under this Section, who is experienced in installing hoisting equipment similar to that required for the Project, and is acceptable to hoisting equipment manufacturer.
 - b. Submit name and qualifications, and the following information for at least three successful, completed projects:
 - 1) Names and telephone numbers of each owner and architect or engineer responsible for project.
 - 2) Approximate contract cost of hoisting equipment.
 - 3) Number of installations.
- B. Component Supply and Compatibility:
- 1. Obtain all equipment included in this Section regardless of component manufacturer, from single hoisting equipment manufacturer.
 - 2. Hoisting equipment manufacturer shall review and approve or prepare all submittals for components furnished under this Section.
 - 3. Components shall be specifically constructed for specified service conditions and shall be integrated into overall equipment assembly by hoisting equipment manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
- 1. Shop Drawings:
 - a. Complete description of materials and equipment in sufficient detail to allow comparison with requirements of this Section.
 - b. Drawing showing arrangement of system and clearances, including plan and sections.
 - c. Specialized wiring diagrams, if applicable.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications identification of materials of construction, rated capacities, dimensions of individual components, and finishes.
 - b. Make, model, weight and horsepower of each component.
 - c. External power requirements for each component.
 - 3. Testing Plans: Plan for load testing at the Site.
- B. Informational Submittals: Submit the following:
- 1. Certificates:
 - a. Manufacturer's installation certification.
 - 2. Manufacturer's Instructions:
 - a. Special shipping, storage and protection, and handling instructions.
 - b. Routine maintenance requirements prior to start-up.
 - 3. Field Quality Control Submittals:
 - a. Load test report, including copy of certifications of test weights.

4. Manufacturer's Reports: Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained.
 5. Qualifications Statements:
 - a. Manufacturer, when qualifications are requested by ENGINEER.
 - b. Installer, when qualifications are requested by ENGINEER.
- C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
 - a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
 - b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
 2. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to materials or equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
 3. Conform to Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
1. Keep materials and equipment off ground using pallets, platforms, or other supports. Protect steel, packaged materials, motors, and electronics from corrosion and deterioration.
 2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. System Description:
1. Hoists shall conform to headroom, hook elevation, and side clearance requirements shown and indicated in the Contract Documents, and shall provide required available lift height and capacity.
 2. Electrical equipment and controls shall be rated NEMA 4X.
- B. Performance Criteria:
1. Electrically-operated Hoists:

Designation	Pump Removal
General Location:	Garage
Hoist Type:	Chain
Ambient Conditions (deg F, Indoor/Outdoor):	60 – 90, Indoor
Number Required:	3
Capacity (tons):	4
Required Lift (feet):	30
Max Required Hook Elevation:	8'-3"
Lift Speed (fpm):	10
Hoist Horsepower:	3
Trolley Type:	Motor-Driven
Trolley Speed (fpm):	10
Trolley Horsepower:	1
Volts:	480
Phase:	3
Frequency (Hertz):	60
Control:	Pendant
Electrification:	Bar

2.2 MANUFACTURERS

- A. Manufacturers: Provide equipment of one of the following:
1. Columbus McKinnon.
 2. Reliable, by Stanspec, a division of American Crane & Hoist Corp.
 3. Or equal.

2.3 DETAILS OF CONSTRUCTION

- A. Electric-powered Chain Hoists:
1. Comply with ASME B30.16 and ASME HST-1. Welding shall comply with AWS D14.1.
 2. Design Stresses: Provide load bearing components so that stresses at rated load shall not exceed 20 percent of average ultimate strength of material.
 3. Hooks: Provide latch-type hooks that are free to rotate through 360 degrees under all loading conditions. Hooks shall be heat-treated drop forged steel.
 4. Hoisting Chain: Hardened alloy steel.
 5. Lift Wheel: Machined and heat treated alloy steel with hardened steel chain guides.
 6. Gearing: Machined and heat treated helical gear system. Hoist gearbox shall be in accordance with AGMA 6013-A. Provide means for adequate lubrication of gearing.
 7. Bearings: Bearings shall be permanently lubricated type.
 8. Hoist Brakes: Provide hoist with two brakes: motor brake and load brake. Each brake shall be capable of supporting and holding 125 percent of full rated load without electrical power.
 9. Provide overload protection device that prevents lifting of loads beyond rated

capacity.

10. Motor: Motor shall be specifically constructed for reversing and hoisting service and capable of operating at specified loads. Motor shall be heavy-duty, thermally protected, 30-minute rated, H4 duty cycle, with Class F insulation. At rated frequency, motor shall be capable of operating at plus ten percent of rated motor voltage.
11. Hoist shall contain upper and lower adjustable limit switches.
12. Housing and Covers: Cast aluminum.
13. Provide supports, fasteners, brackets, chain container, and all accessories required.

B. Electric-powered Trolleys:

1. Trolley shall be constructed to accept the specified hoist using lug-mounted suspension, and shall be of sufficient size and strength to transport rated load of the associated hoist.
2. Trolley frame shall have steel side plates that wrap around trolley to provide protective lug to prevent trolley from falling off monorail in event of wheel axle failure.
3. Wheels: Wheels shall be fabricated of hardened steel or cast iron and shall be constructed to run on specified beam. Wheels shall have uniform surface hardness and capable of carrying maximum applied load.
4. Trolley motor shall be thermally protected, with Class B insulation.
5. Gearing: Machined and heat treated spur gear system. Gearbox shall be in accordance with AGMA 6013-A. Provide means for adequate lubrication of gearing.
6. Bearings: Bearings shall be ball or roller type, permanently lubricated.

2.4 CONTROLS FOR ELECTRIC HOIST AND TROLLEY

A. Hoist Speed Control:

1. Hoist motor shall be single-speed or dual-speed, as specified in Article 2.1 of this Section, with magnetic control.
2. Each magnetic control shall have contactors sized for specified class of service. Reversing contactors shall be mechanically and electrically interlocked to prevent line-to-line faults, and shall be provided with automatic reset thermal overloads for hoist motor.

B. Control Station:

1. Control station shall be rated in accordance with Paragraph 2.1.A of this Section. Motion control pushbuttons shall spring return to "Off" position when released. Function of each pushbutton shall be clearly marked and indicate direction of resultant motion.
 - a. For single-speed hoists, control station shall contain the following functions:
 - 1) "POWER ON"
 - 2) "POWER OFF"

- 3) "HOIST UP"
- 4) "HOIST DOWN"
- 5) "TROLLEY – FORWARD"
- 6) "TROLLEY – REVERSE"
- 2. Pendant Control:
 - a. When specified in Article 2.1 of this Section, control of hoist and trolley shall be by pendant pushbutton control station.
 - b. Pendant mounting shall include steel cable to provide strain relief for pendant's electric control cable. Provide isolating transformer to reduce voltage to 120 volts (or less) in control circuits.
 - c. Mount control pendant and cable on 12-gage stainless steel C-track festoon system that allows hoist and trolley to move independently of control station.

2.5 ELECTRIFICATION

- A. Eight-bar Conductor:
 - 1. When specified in Article 2.1 of this Section, provide enclosed rigid type contact conductor system mounted parallel to crane runway or track. Conductors shall comply with NEC Article 610. Contact conductors shall be sized to carry required current to all motors when operating at rated conditions. Collectors shall be shoe-type and be constructed to reduce to a minimum sparking between shoe and contact conductor.
 - 2. System Components: Electrification system shall include the following:
 - a. Conductor bars.
 - b. Hanger clamps for conductor bars.
 - c. Power feeds to conductor bars.
 - d. End caps for conductor bars.
 - e. Torsion spring collectors.
 - f. Special tooling to install electrification system.
 - g. Cable and connectors for power and control connections.

2.6 FINISHING

- A. Surface Preparation and Painting:
 - 1. Surface preparation and shop painting is required for ferrous metals, equipment, and accessories. Do not paint stainless steel and machined surfaces.
 - 2. Clean and apply in the shop prime coat in accordance with Section 09 91 00, Painting.
 - 3. Apply manufacturer's standard factory finish.
- B. Gears, bearing surfaces, and other machined surfaces shall receive a heavy application of rust-inhibiting coating that shall be maintained during storage and until equipment is placed into operation.

2.7 IDENTIFICATION

- A. Identify component subassemblies with stainless steel nameplates and each labeled with the following:
 - 1. Manufacturer and model number.
 - 2. Date of manufacture with pertinent ratings, operation, and maintenance information.
 - 3. Certification, stamp, or approval to applicable Laws and Regulations.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- B. Inspect and verify that no part of the building, structure, piping, mechanical systems including ductwork, electrical systems including lighting and conduit, or other elements that will interfere with proper operation of hoist along the entire length of monorail track.

3.2 INSTALLATION

- A. Install materials and equipment in conformance with Laws and Regulations, applicable standards, manufacturer's instructions and recommendations, and the Contract Documents.
- B. Refer to Section 05 12 00, Structural Steel Framing, for requirements for hoisting system's supporting steel.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. After installing equipment and associated controls, perform at the Site running tests for hoisting equipment and appurtenances. Should testing indicate malfunction, make repairs and adjustments as required. Repeat testing and adjusting until, in ENGINEER's opinion, installation is complete and equipment is functioning properly and accurately, and is Substantially Complete.
 - 2. Load Test:
 - a. Perform load tests under supervision of manufacturer's factory-trained service technician, in presence of ENGINEER.
 - b. Weights used in load testing shall be certified by a state or local bureau of weights and measures. Submit weight certification as part of the load test report.

- c. Load testing shall conform to ASME B30.11, ASME B30.16, and the following:
 - 1) For electric hoists, power failure test with rated load: Load shall be held suspended when power is removed.
 - 2) Trolley travel full length of monorail with rated load, while verifying that all functions operate properly.
 - 3) Hoist brake drift test with rated load: Lift weight, measure distance to floor, allow five minutes to elapse, and re-measure. Record the results measured. Criteria for Acceptance: No difference in measurements.
 - 4) Upper/lower limit switch test with no load.
 - 5) Emergency stop test with no load.
 - d. Load Test Report: Submit results of load testing as report that lists tests performed, data collected, results of each test, and corrective actions taken (if any). Test report shall be signed by manufacturer's service technician present during testing.
- B. Manufacturer's Services: Provide a qualified, factory-trained service technician to perform the following:
- 1. Instruct CONTRACTOR in installing equipment and assist in the installation of equipment.
 - 2. Inspect and adjust equipment after installation and ensure proper operation, and supervise initial operations and load tests.
 - 3. Instruct OWNER's personnel in operating and maintaining the equipment.
 - 4. Manufacturer's technician shall make a minimum of two visits, with minimum number of hours on-Site for each visit as specified.
 - a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: eight hours.
 - b. Second visit shall be to instruct operations and maintenance personnel. Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
 - 5. Manufacturer's Installation Certification: Submit certification that manufacturer's technician has checked completed installation and equipment, as specified in the Contract Documents, has been provided in accordance with manufacturer's recommendations, and that operation of equipment is satisfactory. Certification shall be signed by manufacturer's technician present at the Site and CONTRACTOR.
 - 6. Training: Furnish services of Supplier's qualified factory trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 - 7. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++

SECTION 43 21 39.13

SUBMERSIBLE END SUCTION PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish and install dry-pit submersible, end suction centrifugal pumps complete and operational with motors, control equipment, and accessories as shown and specified. Anchorage devices are included in the scope of this Section.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before submersible end suction pump Work.

C. Related Sections:

1. Section 05 05 33, Anchor Systems.
2. Section 26 29 23, Low Voltage Variable Frequency Drives.
3. Section 40 05 19, Ductile Iron Process Pipe.
4. Section 40 60 05, Instrumentation and Control for Process Systems

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/HI 1.3, Standard for Centrifugal Pumps for Design and Application.
2. ANSI/HI 1.4, Standard for Centrifugal Pumps for Installation, Operation, and Maintenance.
3. ANSI/HI 1.6, Centrifugal Pump Tests.
4. ANSI/HI 9.1-9.5, Standard for Pumps – General Guidelines for Types, Definitions, Application, Sound Measurement, and Decontamination.
5. ANSI/HI 9.6.2, Standard for Centrifugal and Vertical Pumps for Allowable Nozzle Loads.
6. ANSI/HI 9.6.3, Standard for Centrifugal and Vertical Pumps for Allowable Operating Region.
7. ANSI/HI 9.6.5, Centrifugal and Vertical Pumps for Condition Monitoring
8. ANSI/HI 9.8, Pump Intake Design.
9. ANSI/HI 11.6, Submersible Pump Tests.
10. IEEE 85, Airborne Sound Measurements- Rotating Electrical Machinery.
11. NEMA MG-1, Motors and Generators.

1.3 QUALITY ASSURANCE

A. Supplier's Qualifications:

1. Supplier shall have a minimum of five years experience producing substantially similar equipment to that required for the Project and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section, regardless of component Supplier, from one submersible end suction pump manufacturer.
2. Submersible end suction pump Supplier shall review and approve or prepare all Shop Drawings and submittals for all components provided under this Section.
3. All components shall be suitable for specified service conditions and shall be integrated into overall assembly by the submersible end suction pump Supplier.
4. Pump manufacturer shall supply and assume coordination responsibility for the Variable Frequency Drives as specified in Section 26 29 23, Low Voltage Variable Frequency Drives.

C. Certifications

1. Certification of Compliance:

- a. Obtain certification of compliance with the Contract Documents from the submersible end suction pump manufacturer on manufacturer letterhead; certification by manufacturer's representatives is not acceptable.
- b. Certification shall be worded as follows:
“*[Insert manufacturer's name]* proposes to supply equipment included in Section 43 21 39.13 for the Town of Trumbull, Connecticut, Beardsley Pump Station Comprehensive Upgrade. We have examined the Contract Documents and understand of the Project requirements insofar as they affect the proposed products. We certify that the products will operate satisfactorily under the conditions described in the Contract Documents and that the products meet the requirements of the Contract Documents:

[List exceptions, deviations or changes necessary or recommended to accommodate the proposed products.]

We further certify that the products to be furnished shall conform to the standards listed in Section 43 21 39.13, Submersible End Suction Pumps, and be fully compatible with the variable frequency drives specified in Section 26 29 23, Low-Voltage Variable Frequency Drives, of the Contract Documents.

Authorized Signature & Title

Date”

- c. Provide justification for exceptions, variations, deviations, or changes. ENGINEER will determine whether exceptions, deviations, and changes

are acceptable. Exceptions, variations, deviations, and changes may result in rejection of products.

- d. Provide certification before submitting Shop Drawings. Shop Drawings will not be reviewed prior to receipt of certification.
- e. Acceptance of certification shall not relieve CONTRACTOR of responsibility for adequacy of all products.
- f. Submittal of certification shall not relieve CONTRACTOR and Supplier of requirement to comply with submittal procedures in the Contract Documents.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Shop Drawings of pump controls specified in this Section, including panel layout and wiring diagrams. Conform to Shop Drawing submittal requirements of Section 40 60 05, Instrumentation and Control for Process Systems.
- 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, paint certification (if required) and engineering data including; dimensions, materials, size, weight, and part lists for all components in sufficient detail to allow an item-by-item comparison with the Contract Documents.
 - b. Pump performance data and curves showing overall pump efficiencies, required net positive suction head (NPSH), allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed, and shut-off head. Curves shall range from minimum flow to shut-off head at for full speed and all speed curves specified. For variable speed units, curves shall have at least five speeds plotted between maximum and minimum rpm. Curves shall indicate Preferred Operating Region (POR) and Allowable Operating Region (AOR), as defined in ANSI/HI 9.6.3. Specify recommended ratio of available NPSH divided by required NPSH for water service.
 - c. Motor Data: Furnish certified motor data sheet for previously tested, electrically duplicate motor to that specified, including the following:
 - 1) Speed-torque relationship.
 - 2) Efficiency at 1/2, 3/4, and full load.
 - 3) Power factor at 1/2, 3/4, and full load.
 - 4) Slip at full load.
 - 5) Running light, full load and locked rotor current.
 - 6) Temperature rises and results of dielectric tests.
 - 7) Bearing type and lubrication medium
 - 8) Insulation class and temperature ratings.
 - d. Motor Protection Relay: Register assignments and parameter listing.
- 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Provide pump Supplier's proposed shop testing plan, including complete list of testing facility limitations. At a minimum, shop tests shall include

performance test, hydrostatic test, motor electrical testing, testing for vibration, and NPSH.

- b. Provide proposed field testing plan.

B. Informational Submittals:

1. Certificates: Provide certificate of compliance as specified in this Section.
2. Manufacturer Instructions:
 - a. Provide Supplier's instructions for handling and installing products.
 - b. Setting drawings, templates, and directions for installing anchor bolts and other anchorages.
3. Source Quality Control Submittals:
 - a. Results of shop testing for complete pump and motor unit.
 - b. Location of nearest permanent service headquarters of pump manufacturer to the Site.
4. Field Quality Control Submittals:
 - a. Results of field testing.
 - b. Submit a written report of the results of each visit to Site by pump manufacturer's service representative, including purpose and time of visit, tasks performed, and results obtained.
5. Qualifications Statements:
 - a. Provide Supplier's qualifications as specified in Quality Assurance article of this specification.
6. Pump cradle shop drawings showing dimensions, material of construction, and details of construction.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Manuals:
 - a. Submit complete operation and maintenance manuals, including shop and field test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Provide operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
2. Warranty Documentation:
 - a. Manufacturer's Standard Warranty.
 - b. Special Warranty, if specified.

D. Maintenance Material Submittals: Furnish the following:

1. Spare Parts:
 - a. 1 each - Impeller, impeller bolt, impeller washer.
 - b. 2 - O-ring kit drive unit
 - c. 2 - O-ring kit hydraulic unit
 - d. 1 each - all mechanical seals
 - e. 1 each - all upper and lower bearings
 - f. 1 each - volute and impeller wear rings
2. Tools:
 - a. Furnish two sets of special tools required for normal operation and maintenance of products furnished.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Prior to shipping, completely inspect products to assure that components are complete and comply with all requirements. Box or crate products as required to prevent damage during shipment. Protect machined surfaces and matching connections to prevent damage.
2. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
3. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
4. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:

1. Keep all products off ground using pallets, platforms, or other supports. Protect steel, packaged materials, and electronics from corrosion and deterioration.
2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

1.6 WARRANTY

A. Special Warranty on Submersible End Suction Pumps:

1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, at OWNER's option, remove, or replace materials or equipment specified in this Section and found to be defective for a period of five years after date of Substantial Completion. Replacement value of items regularly subject to wear in normal use, such as seals, bearings, impellers, rotors, and stator, may be prorated

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. System Description:

1. Pumps shall be submersible end suction centrifugal type. Pumps shall be constructed for operation under complete submersion, partial submersion, and dry conditions. Each pump shall be suitable for its intended service.
2. Pumps shall comply with ANSI/HI 1.3, ANSI/HI 9.6.3, and ANSI/HI 9.8.

B. Design and Performance Criteria: Each pump shall comply with the following:

Design Conditions	Low Capacity Pump	High Capacity Pump
Location:	Pump Room	Pump Room
Use:	Low/Average Flow	Above Average/Peak Flow
Fluid Pumped:	Screened wastewater	Screened wastewater
Number Required:	2	2
* Design Flow at First Design Point (gpm)	2100	7337
* Design Total Head at First Design Point (ft)	45	126
Minimum Pump Efficiency at First Design Point (percent)	78%	79%
** Available NPSH at First Design Point (ft)	31	29.5
Min. Sphere Diameter (in.):	3.75	3.75
Discharge Nozzle Dia. (in.):	8	12
*** Flow at Second Design Point (gpm)	1800	3600
Total Head at Second Design Point (ft)	42	55
Head at Zero Flow (ft)	32.5	32.5
**** Motor Size (hp) and Maximum Speed (rpm):	44 hp 1190 rpm	385 hp 1190 rpm
Motor Voltage/Phase/Hertz	460V / 3Ph / 60Hz	460V / 3Ph / 60Hz
Fluid Temperature (deg. F):	70	70
Notes: * At design operating flow for low capacity pump; peak station flow for high capacity pump. ** Required NPSH shall be for size impeller furnished. If impeller is trimmed, provide curve for impeller as trimmed. *** Flow at Second Design Point for Low Capacity Pump equals maximum flow from one pump when both run simultaneously; Flow at Second Design Point for High Capacity Pump equals minimum flow at which High Capacity Pump will operate. **** At all points on pump curve, pump horsepower requirements shall not exceed specified motor horsepower.		

2.2 MANUFACTURERS

- A. Low Capacity Pump Products and Manufacturers: Provide products of one of the following:
1. Flygt Corporation, Model NT 3202 MT 3~ 642.
- B. High Capacity Pump Products and Manufacturers: Provide one of the following:
1. Flygt Corporation, Model NT 3312 3~ 670.

2.3 DETAILS OF CONSTRUCTION

- A. Pump Materials and Construction (Extra Heavy Duty):
1. General:
 - a. Construct pumps for fluid service specified.
 - b. Construct pumps and appurtenances, including cable, for continuous submerged operation without leakage in specified depth of water.

2. Pump Body and Externals:
 - a. Stator casing, oil casing, sliding bracket, volute, and impeller shall be close-grained, gray cast iron.
 - b. Provide lifting eye or stainless steel lifting bail on each pump capable of bearing weight of pump during removal and installation.
 - c. Securely fasten to each pump brass or stainless steel nameplate engraved with pump manufacturer's name, pump model and serial number, pump's rated flow and head, speed, and other pertinent data.
 - d. External Hardware: Bolts, nuts, and cap screws shall have hexagonal heads and be Type 316 stainless steel.
 3. Impeller shall be enclosed single- or double-vane, non-clog, dynamically balanced. Wear ring shall be stainless steel.
 4. Shaft: Stainless steel.
 5. Seals: Single-mechanical upper seal and single-mechanical lower seal. Seal faces shall be tungsten carbide. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. Each seal shall operate independently of the other.
 6. Bearings: Anti-friction, grease- or oil-lubricated with minimum B-10 life of 100,000 hours.
- B. Motors for Extra Heavy Duty Pumps:
1. Motor shall be stainless steel solid shaft, ball bearing type. Motor casing shall be air-filled or oil-filled and watertight with moisture resistant Class H, 180 degrees C insulation. Voltage, phase, and frequency shall be as specified in "Design and Performance Criteria" in this Section.
 2. Motor shall be NEMA Design B, normal starting torque, normal slip, squirrel cage induction type, continuous duty.
 3. Isolate cable entry with internal terminal board.
 4. Motor shall be capable of continuous operation in a non-submerged condition without damage. Pump and motor shall be capable of intermittent operation up to 12 starts per hour in non-submerged condition, without damage.
 5. Motor shall be non-overloading for entire pump operating curve, shall have 1.15 service factor, and provide full rated horsepower with a voltage unbalance of three percent. Motors for use with variable frequency drives shall have insulation system constructed in compliance with or exceeding NEMA MG-1 Part 31.
 6. Motor cable shall be suitable for submersible duty and be so indicated by code or legend permanently applied to cable.
 7. Motor thrust bearings shall be capable of continuous thrust loads under all conditions of pump operation from zero head to shut-off. Anti-friction bearings shall be rated for B-10 life of 100,000 hours.
 8. Motor Sensors:
 - a. For supplemental motor protection, each pump motor shall be equipped with at least three thermal sensors embedded in stator windings and wired to the associated control panel.
 - b. Provide leakage sensor in lower part of stator housing, wired to leads in motor's watertight terminal chamber.

- c. Motor sensor cables shall be provided with a electromagnetic compatibility filter in the motor terminal box.
- 9. Motors shall have over-temperature sensors in motor windings.
- 10. Motors shall be in accordance with all current applicable standards of NEMA, IEEE and ANSI. Motors for use with variable frequency drives shall have insulation system constructed in compliance with or exceeding NEMA MG-1 Part 31.
- 11. Motors shall be capable of carrying full load current continuously without injurious temperature rise under all conditions of submersible operation.
- 12. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of pump operation from zero head to shut-off.
- 13. Cooling System:
 - a. Each pump/motor unit shall be provided with an integral, glycol-cooled cooling system.
 - b. Drilled and threaded ports shall be provided for the connection of standby flushing water. The motor water jacket shall provide heat dissipation for the motor when operating continuously at full load, in a dry-pit installation with ambient temperature up to 104 degrees F.
 - c. The internals to the cooling system shall be non-clogging.
 - d. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4-inch diameter located 180 degrees apart.
- C. Accessories: Provide the following for each pump unless otherwise specified.
 - 1. Anchor bolts and anchorage devices per Section 05 05 33, Anchor Systems.
 - 2. Inlet Elbow: Conforming to Section 40 05 19, Ductile Iron Process Pipe.
 - a. Inlet Elbow for High Capacity Pumps shall be 18"x14" reducing long radius elbow as provided by manufacturer.
 - b. Inlet Elbow for Low Capacity Pumps shall be 12"x10" reducing long radius elbow as provided by manufacturer.
 - 3. Pump Cradle: Pump manufacturer shall provide two (2) cradles to support the pump in the vertical position without the volute. Supporting the pump in the cradle shall not damage the pump or void the warranty.

2.4 CONTROLS

- A. Provide pumps with the following accessories and controls:
 - 1. Pumps shall be controlled at the Main Control Panel (MCP) based on fluid level in wet well as described in Section 40 60 05, Instrumentation and Control for Process Systems.
- B. Monitoring Equipment:
 - 1. General:
 - a. Provide power and control cables and motor protective control devices as specified in Paragraph 2.3.B of this Section and in Paragraph 2.4.B.2., below, of this Section.

- b. Instrumentation and control system operational functional requirements relative to pump applications are shown and specified in applicable instrumentation and control Specifications in Division 40.
- 2. Motor Protective Control Devices for Low Capacity Pumps:
 - a. For each pump motor assembly:
 - 1) Provide solid-state monitoring controller with SPDT dry contact control outputs for:
 - a) Stator winding overtemperature.
 - b) Stator housing leakage sensor.
 - 2) Install solid-state monitoring controller in the VFD Enclosure.
- 2. Motor Protective Control Devices for High Capacity Pumps:
 - a. For each pump motor assembly: Each pump motor assembly shall be furnished with a pump monitoring protection relay system (MPR). The additional motor protection information shall be brought to the Main Control Panel (MCP). The MPR shall be the Flygt MAS 711 with optional accessories as identified below. The motor protection devices will be furnished under this section, however they shall be installed within the VFD panel specified in Section 26 29 23, with proper shielding and separation of low and high voltage signaling. Coordinate fabrication and submittal of the VFD panels with the installation of the required MPR components.
 - b. The motor protection information (see below) will be configured over an Modbus RTU communications interface to communicate to the MCP.
 - c. With the MPR submittal, the manufacturer shall furnish a register map listing with all required register assignments for all signals transmitted from the pump MPR, indicating the specified parameter, the parameter name in the MPR, the register assignment to be transmitted.
 - d. Provide a pump memory unit sized for local storage of unit information, listing of installed sensors, and operational data.
 - e. The signals to be monitored include at a minimum:
 - 1) Vibration
 - 2) Motor winding temperatures (3 locations)
 - 3) Stator temperature
 - 4) Thrust bearing temperature
 - 5) Water intrusion within the motor stator chamber
 - 6) Water intrusion in the pump power cable junction chamber
 - f. Accessories shall be provided with the MPR as follows:
 - 1) Upper support bearing temperature
 - 2) Vibration in the power cable junction chamber
 - 3) Power analysis, including system pump/motor current, individual phase current, current imbalance, system voltage, individual line voltage, voltage imbalance, system power (KW), power factor, energy consumption.
 - g. All signals shown above shall be provided to MCP for display and alarming.

2.5 FINISHING

- A. Shop Finishing:
 - 1. At the factory, pumps, motors, and appurtenances shall receive manufacturer's standard finish paint system suitable for service conditions specified in this Section. Finish color of pumps in dry pit service shall be same as color of related process piping.
 - 2. Coat machined, polished, and non-ferrous surfaces with corrosion prevention compound.
- B. Field painting shall conform to Section 09 91 00, Painting. Touch-up of factory-applied finishes shall be compatible with factory-applied finish and specified service conditions. Dry pit pumps with factory-applied finish that does not match color of related piping shall be field-painted to match color of related process piping.

2.6 SOURCE QUALITY CONTROL

- A. Pump Shop Tests: Shop Test all pumps provided under this Section.
 - 1. Hydrostatically test pump bodies per ANSI/HI 1.6, to the greater of: twice specified pump discharge head at Design Point No. 1, or 1.5 times pump's shutoff head.
 - 2. Performance Test: Operate each pump assembly from zero to maximum capacity as shown on pump curve in approved Shop Drawing. Present results of test in plot of test curves showing head, flow, horsepower, efficiency, and current. Obtain data at minimum of five evenly spaced capacity points along curve including shut-off, design points, and minimum head for which pump is designed to operate. Conduct tests per ANSI/HI 1.6 and ANSI/HI 11.6.
 - 3. Each test shall be witnessed by professional engineer registered and licensed in the state where pumps are fabricated, who may be an employee of pump manufacturer. Professional engineer shall sign, date, and seal all copies of test results and shall certify that hydrostatic tests were performed. Professional engineer's name and registration number shall be clearly legible on the seal.
 - 4. Do not ship products from factory until ENGINEER has accepted test results.
- B. Motor Tests and Data:
 - 1. For each motor, provide an inspection report for job motor or a previously tested electrically duplicate motor. Provide the following minimum data:
 - a. Running light current.
 - b. Locked rotor current.
 - c. Winding resistance measurement.
 - d. High potential test.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Examine conditions under which products are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install products in conformance with manufacturer's instructions and recommendations, and the Contract Documents.
- B. Anchorages:
 - 1. Install pumps on concrete bases. Provide anchorages in new or existing concrete, as applicable, per equipment manufacturer's recommendations and the Contract Documents. Equipment manufacturer shall supply templates to facilitate location of anchorages for equipment. CONTRACTOR shall coordinate with Supplier to assure timely receipt of required templates.
 - 2. For pumps installed in dry pit applications, install grout between pump and concrete base per recommendations of pump manufacturer.
- C. General:
 - 1. Conform to ANSI/HI 1.4.
 - 2. Perform all fitting required for installation. Set products accurately in location, alignment, and elevation, plumb and true.
 - 3. Provide utility connections per the Contract Documents. Support piping and valves independent of pump. Verify that utilities and valves are tested and operational before placing equipment into operation. When pumps are connected to piping with rigid hardware, connection of discharge nozzle to piping shall conform to ANSI/HI 9.6.2.
 - 4. Align and adjust products and piping in presence of ENGINEER
 - 5. Provide for initial operation lubricants recommended by equipment manufacturer
 - 6. Prior to energizing motor driven equipment, rotate drive motor by an external source to demonstrate free operation of mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.
- D. Field painting shall conform to Section 09 91 00, Painting.
- E. Conform to Section 01 75 11, Checkout and Startup Procedures.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Following installation, CONTRACTOR and qualified field service representative of equipment manufacturer shall conduct operating tests of all equipment, functions, and controls at Site, in presence of ENGINEER. Should tests result in malfunction, make necessary repairs, revisions, and adjustments and restart test from beginning. Repeat tests and repairs, revisions, and adjustments until, in opinion of ENGINEER, installation is complete and

equipment is functioning properly and accurately, and is ready for permanent operation.

2. Conform to Section 01 79 13, System and Facility Performance Testing Procedures.
 3. Field Operating Test:
 - a. Field test equipment and its controls in local mode, followed by demonstrating proper operation and controls in automatic mode. Demonstrate that each part and component of system individually and all parts and components together function properly in manner intended. Total duration of testing shall be 48 hours, continuous and uninterrupted, in automatic mode. All testing equipment and manpower shall be by CONTRACTOR.
 - b. Conform to applicable provisions of ANSI/HI 9.6.5.
- B. Manufacturer's Services: Provide qualified, factory-trained serviceman to perform the following:
1. Instruct CONTRACTOR in installing equipment.
 2. Inspect and adjust equipment after installation and ensure proper operation.
 3. Test-operate the products in presence of ENGINEER and verify that equipment conforms to Contract Documents.
 4. Instruct OWNER's personnel in operating and maintaining the products.
 5. Manufacturer's representative shall make a minimum of six visits, with a minimum of eight hours onsite for each visit. First visit shall be for assistance in installing equipment; second visit shall be for checking completed installation and start-up of system; third visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
 6. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of products. Training requirements, duration of instruction, and other qualifications shall be per Section 01 79 23, Instruction of Operations and Maintenance Personnel.
 7. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to Site shall be included in the Contract Price.

+ + END OF SECTION + +

SECTION 43 26 21

ALUMINUM SLIDE GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install aluminum slide gates and appurtenances complete and operational.
2. Included are slide gates, anchorage systems, and all appurtenances.
3. Extent of the equipment is shown on the Aluminum Slide Gate Schedule located at the end of this Section.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the aluminum slide gates Work.

C. Related Sections:

1. Section 03 00 05, Concrete.
2. Section 05 05 33, Anchor Systems.
3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Gear Manufacturers Association, (AGMA).
2. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 276, Specification for Stainless Steel Bars and Shapes.
 - b. ASTM A 320/A 320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
 - c. ASTM B 21/B 21M, Specification for Naval Brass Rod, Bar and Shapes.
 - d. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - e. ASTM B 308/B 308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - f. ASTM B 584, Specification for Copper Alloy Sand Castings for General Application.
3. American Water Works Association, (AWWA).
 - a. AWWA C501, Cast-Iron Sluice Gates.
4. National Electrical Code, (NEC).
5. National Electrical Manufacturers Association, (NEMA).

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single aluminum slide gates manufacturer.
 - 2. The aluminum slide gates equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the aluminum slide gates equipment manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Fabrication, assembly and installation diagrams.
 - b. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
 - c. Wiring diagrams for electric motor operators.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications and engineering data.
- B. Informational Submittals: Submit the following:
 - 1. Shop Test Results:
 - a. Submit results of the required shop tests.
 - 2. Field Test Results:
 - a. Submit a written report giving the results of the required field tests.
- C. Closeout Submittals: Submit the following:
 - 1. Operation and Maintenance Manuals:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work.

Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT DESCRIPTION

A. General: Design equipment to be suitable for the process and service conditions described below and in the Aluminum Slide Gate Schedule, located at the end of this Section.

1. Design slide gates to safely withstand conditions listed in gate schedule.
2. Gates shall be substantially watertight with leakage less than 0.5 gpm per foot of seating perimeter at design head.
3. Manual operators shall turn right to close, unless otherwise specified. Operators shall indicate the direction of operation.
4. Bolts, studs, cap screws, and adjusting screws shall be of ample section to withstand the force created by operation of the gate under a full head of water.
5. Downward opening gates shall be capable of being lowered to an elevation below the invert of the channel or opening.
6. Slide gates shall open to not less than 6-inches above the maximum water level in the channel in which they are installed.

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:

1. Rodney Hunt Company.
2. Whipps.
3. Or equal.

2.3 FABRICATION

A. Materials of Construction:

1. Aluminum: For frame, slide and yoke, ASTM B 209, Alloy 6061; or ASTM B 308/B 308M, Alloy 6061. All metal for gate parts shall have a minimum thickness of 1/4-inch.

2. Stainless Steel: For all parts, ASTM A 276 Type 316, unless otherwise specified.
 3. Bronze Casting: For operating nut, thrust nut and lift nut, ASTM B 584, Alloy 865.
 4. All bolts, studs, cap screws and adjusting screws shall be of Type 316 stainless steel.
 5. Bolts and nuts shall have hexagon heads.
 6. Gasket material and installation shall conform to manufacturer's recommendations.
- B. Disc:
1. Fabricate the slide or disc of aluminum plate reinforced with structural shapes attached by welding.
 2. Provide reinforcing to limit deflection under full head to not more than 1/360 of the span.
 3. Extend reinforcing ribs into the guides overlapping the seating surface of the guide.
 4. Weld stem mounting guides to the disc.
- C. Disc Guides:
1. Guides shall be of aluminum incorporating a sandwich type construction using plates and structural angles.
 2. Provide reinforcing to limit deflection under full head to not more than 1/360 of the span.
 3. Extend reinforcing ribs into the guides overlapping the seating surface of the guide.
 4. Weld stem mounting guides to the disc.
- D. Stem:
1. Operating stems shall be of Type 316 stainless steel of minimum sizes shown or specified.
 2. Design stem to transmit in compression at least 2-1/2 times the rated output of the operating mechanism with an 80-pound effort on the crank or handwheel. Determine the critical buckling load using the Euler column formula, using $C = 2$. Where hydraulic cylinder lifts are used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic cylinder with a pressure equal to the maximum working pressure of the hydraulic fluid supply. Where electric motor driven lifts are used, the stem design force shall not be less than 1.25 times the output thrust of the unit in the stalled motor condition.
 3. Stems shall have a slenderness ratio (L/R) less than 200.
 4. Threaded portion of the stem shall have machined cut threads of the Acme type. Join stems of more than one section by stainless steel couplings threaded and keyed, or bored and pinned to the stems. All threaded and keyed couplings of the same size shall be interchangeable. Provide rising stems with an adjustable stop collar on the stem.
 5. Connect the stem to the disc by means of a bolted connection.

- E. Yoke (For Self Contained Type Gates):
1. Furnish tops of the extended guides with a yoke for mounting of the lifting device.
 2. Construct the yoke of structural shapes of sufficient strength to take the full thrust created by operating the gate under the maximum specified head.
 3. Attach the yoke to the framework by bolting or welding to permit removal of the gate slide and stem.
- F. Seals:
1. Mount a specially shaped resilient seal on the bottom of the disc to provide flush-bottom closure for slide gates. As an alternate, a poured urethane seal shall be mounted in the invert of the frame to form a flush bottom seal.
 2. Shape of the seal shall produce a seating surface having a minimum width of 3/4-inch, and the seal will extend beyond the seating surface of the frame.
 3. Vertical face of the seal shall be in contact with the seating surface of the guide to provide a proper seal at the corners.
 4. Provide gates with "J" seals along the sides of the frames for water leakage protection.
 5. Provide downward opening gates with "J" seals along the bottom of the frames.

2.4 APPURTENANCES

- A. Stem Guide:
1. Stem guides shall be cast-iron, bronze bushed, mounted on cast-iron brackets.
 2. Guides shall be adjustable in two directions and shall be spaced so that stems have a maximum unsupported length of 84-inches.
 3. Anchor bolts for stem guides shall be Type 316 stainless steel.
- B. Stem Cover:
1. Furnish all stems with a clear polycarbonate or butyrate plastic pipe stem cover. Furnish covers with a cast aluminum adaptor for mounting covers to floor stands. Stem covers shall be designed and furnished with gasketing and breathers to eliminate water intrusion into operators and condensation within the covers.
 2. Engrave the covers with legible markings showing as a minimum the gate position at 1/4 open, 1/2 open, 3/4 open and full open.
- C. Manual Operated Floor or Bench Stand:
1. Manual operation shall be by handwheel or crank operated floorstand or benchstand as shown and specified.
 2. Handwheel-operated type shall be without gear reduction and crank-operated type will have either a single or double gear reduction, as required. Each type shall be provided with a threaded cast manganese bronze lift nut to engage the operating stem.
 3. Provide anti-friction bearings to properly support both opening and closing thrusts.

4. Stands shall operate the gates under the specified operating head with not greater than a 40-pound pull on the crank or handwheel.
5. All components shall be totally enclosed in a cast-iron weatherproof housing. Provide positive mechanical seals to exclude moisture and dirt and prevent leakage of lubricant out of the unit.
6. Provide lubricating fittings for all gears and bearings.
7. Stands shall include a cast-iron pedestal designed to position the input shaft approximately 36-inches above the operating floor. An arrow with the word "OPEN" shall be permanently attached or cast on the floorstand indicating the direction of rotation to open the gate.
8. Removable cranks shall be cast-iron with a revolving brass grip. Removable handwheel shall be fabricated steel designed for rough treatment and minimum weight.
9. For self-contained type gates, the distance between handwheel or crank operator and the operating floor shall be 36-inches minimum and 48-inches maximum.
10. Crank-operated gates shall be provided with nut-operator drives as noted on the Aluminum Slide Gate Schedule, located at the end of this Section.
11. Operators shall be furnished with a limit switch to indicate fully closed position, where shown.
12. Provide mechanical stops adjustable $\pm$ five degrees at each end of travel.

2.5 SURFACE PREPARATION AND PAINTING

- A. Motors, frames, all ferrous metal surfaces, appurtenances, etc., shall receive shop primer coating conforming to the requirements of Section 09 91 00, Painting.
- B. Surface preparation and painting shall conform to the requirements of Section 09 91 00, Painting.
- C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.
- D. CONTRACTOR shall certify, in writing, that the shop primer and finish coating system conforms to the requirements of Section 09 91 00, Painting.

2.6 ANCHOR BOLTS

- A. Furnish anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturer. Provide hooked anchor bolts for direct embedment during placement of concrete. Anchor bolt materials shall be of Type 316 stainless steel and shall conform to the requirements of Section 05 05 33, Anchor Systems.

2.7 SPECIAL TOOLS

- A. Furnish two sets of any special tools required for normal operation and maintenance.
- B. Special tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

2.8 LUBRICANTS

- A. Furnish all oil and grease as required for initial operation. Use products recommended by the manufacturer.

2.9 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Test each slide gate fully assembled in the vertical position for proper seating.
 - 2. Fully open and close gate disc in its guide system to ensure that it operates freely.
 - 3. Operate and test floor stands, bench stands, and motor operators to ensure proper assembly and operation.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall inspect and verify that structures or surfaces on which equipment will be installed have no defects, which will adversely affect installation. Inspect all equipment prior to installation. Promptly report defects, which may affect the Work to ENGINEER.

3.2 INSTALLATION

- A. Install in a manner and to the tolerances recommended by the equipment manufacturer.
- B. Brace guides and frames during placement of concrete.
- C. Set anchor bolts in accordance with approved manufacturer's drawings.
- D. Provide minimum of 1-inch of non-shrink grout below all floorstands.

3.3 FIELD PAINTING

- A. Field painting shall conform to the requirements of Section 09 91 00, Painting.

3.4 FIELD TEST

- A. Perform operating tests to demonstrate that the equipment operates in the manner intended.
- B. Make adjustments required to place equipment in proper operating condition.
- C. Leakage Tests:
 - 1. Maximum permissible leakage shall be in accordance with Paragraph 2.1.A.2., above. Reduce leakage to the specified maximum by adjusting or replacing the slide gate.
- D. Submit report of test results.

3.5 FIELD QUALITY CONTROL

- A. All equipment will be tested by CONTRACTOR at the Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.

3.6 MANUFACTURER'S SERVICES

- A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 4 visits, minimum 2 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
- B. All costs, including travel, lodging, meals and incidentals, for the additional visits there shall be at no additional cost to the OWNER.

3.7 ALUMINUM SLIDE GATE SCHEDULE

- A. Conform to type, size, operation and other data specified, unless otherwise approved by ENGINEER.
- B. Identification Code:
 - 1. Type:
 - a. EF-Embedded Frame.
 - b. FF-Flat frame.

- c. EFFB-Embedded Frame, Flush Bottom with Resilient Seal.
 - d. FFFB-Flat Frame, Flush Bottom with Resilient Seal.
 - e. SM-Surface Mounted Frame.
 - f. WG-Downward Opening Weir Gate.
2. Operation:
- a. FSHW - Floor stand, handwheel operated.
 - b. FSCO - Flood stand, crank operated.
 - c. FSMO - Floor stand, electric motor operated.
 - d. FSHO - Floor stand, hydraulic cylinder operated.
 - e. FSPO - Floor stand, portable operator.
 - f. BSHW - Benchstand, handwheel operated.
 - g. BSCO - Benchstand, crank operated.
 - h. BSMO - Benchstand, electric motor operated.
 - i. BSHC - Benchstand, hydraulic cylinder operated.
 - j. BSPO - Benchstand, portable operator.

ALUMINUM SLIDE GATE SCHEDULE		
1. Designation	Influent Gate	Isolation Gate
2. Location:	Wet Well	Hydraulic Connection between two Wet Wells
3. Size (in.) (W*x H):	18"x24"	12"x12"
4. Type:	SM	SM
5. Invert Elev.:	62.0	54.8
6. Operating Floor Elev.:	67.47	67.47
7. Operation:	FSCO	FSCO

*The width specified does not include the amount within the frame.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 44 31 19

PACKAGED ODOR CONTROL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, equipment, materials, and incidentals as required to furnish, install, check, calibrate, test, document, start-up, and place in satisfactory operation the Odor Control System as shown and as specified.
2. The Odor Control System shall include, but not be limited to the following:
 - a. Interconnecting ductwork, fittings, accessories and supports from exhaust source through exhaust stack.
 - b. Odor control fan.
 - c. Odor control vessels.
 - d. Start-up performance testing.
 - e. Spare parts as recommended by the manufacturer.

B. General:

1. Descriptions contained hereinafter are for guidance and to show the functions desired. They do not describe or specify all components to interface equipment. All parts and equipment necessary to meet functional requirements shall be provided and fit within the dimensions and configuration shown.
2. The mechanical, structural, instrumentation and electrical design has been based on an Odor Control System herein and on the drawings. The cost of any changes and modifications to mechanical, structural, instrumentation or electrical facilities necessary to adapt alternate equipment to the layout and design shown shall be borne by CONTRACTOR. Clearances shown shall be maintained. Any such proposed changes or modifications are subject to review and acceptance by the ENGINEER in accordance with the Special Provisions.
3. CONTRACTOR shall be completely responsible for the proper operation and functions of the Odor Control System herein specified. CONTRACTOR shall be responsible for coordination of all interfaces with other contractors to achieve the required Odor Control System operation.
5. Electrical conduit and wiring between all integral odor equipment shall be furnished and installed. Conduit shall conform to the requirements of Section 26 05 33.13, Rigid Conduits.
6. Some equipment will require modification from the manufacturer's standard to meet these Specifications.
7. When two or more units of equipment for the same purpose are required they shall be the product of one manufacturer.
8. All fasteners (nuts, bolts and washers) used for the Odor Control System shall be of Type 316 stainless steel.
10. All components of each Odor Control System shall conform to the requirements of Section 09 91 00, Painting.

C. Related Sections:

1. Section 03 30 05, Concrete.
2. Section 05 05 33, Anchor Systems
3. Section 09 91 00, Painting.
4. Section 23 31 13, Metal Ductwork
5. Section 44 31 83, Adjusting and Balancing Odor Control Systems.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American National Standards Institute, (ANSI).
2. American Society of Heating, Refrigerating and Air Conditioning Engineers, (ASHRAE).
3. Sheet Metal and Air Conditioning Contractors National Association, (SMAC-NA).
 - a. HVAC Duct Construction Standards.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least five installations, of the same size and type, in satisfactory operation for at least five years.

B. When two or more units of equipment for the same purpose are required they shall be the product of one manufacturer.

D. Ductwork Manufacturer's Qualifications:

1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the above grade and below grade ductwork.
2. Engage a firm, which can show successful experience in the fabrication and erection of ductwork systems of scope and type similar to the required Work.

E. Installer Qualifications:

1. Engage a single installer with undivided responsibility for performance and other requirements who is regularly engaged in ductwork installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.

F. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.

1. Local and State Building Codes and Ordinances.
 - a. The BOCA National Building Code.
 - b. The BOCA National Mechanical Code.
 - c. Uniform Building Code.
2. Underwriters' Laboratories, Incorporated.

3. National Fire Protection Association.
- G. Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the production of such items and have a successful history of product acceptability, as interpreted by ENGINEER.
- H. Responsibilities:
1. In order to centralize responsibility, it is required that all equipment provided under this Section be obtained from a single supplier or manufacturer who shall assume full responsibility for the completeness of the system. The supplier or manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.
 2. The sole responsibility for proper operation of the Odor Control System shall rest with CONTRACTOR.
- I. Listing, labeling or marking, as conforming to the Standards of Underwriters' Laboratories, Inc., American National Standards Institute, Inc., United States Bureau of Mines, or other nationally recognized testing organization approved by Code, on various pieces of equipment furnished shall be prima facie evidence of conformity with the approved standards for safety to life and property.
- J. Prior to conducting any Odor Control System testing, CONTRACTOR shall demonstrate that all meters and test equipment have been calibrated, charged and are in good operating condition one working day before the test date. CONTRACTOR shall also verify there is sufficient test gas to conduct testing for specified durations at specified concentrations.
- K. CONTRACTOR shall provide certifications that all stainless steel accessories including hangers and supports for FRP and HDPE ductwork are Type 316 stainless steel.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. CONTRACTOR shall submit for review to ENGINEER, sufficient literature, detailed specifications, and drawings to show dimensions, make, style, speed, size, type, horsepower, service factors, efficiency, materials used, design features, internal construction, weights, and any other information required by ENGINEER for review of all odor control equipment. No odor control equipment will be accepted, and installation will not be allowed until such review has been completed.
 - b. Ductwork Shop Drawings: Submit the following:
 - 1) 1/4-inch scale duct layouts.
 - 2) Dimensions.
 - 3) Details of construction.
 - 4) Details of installation.
 - 5) Manufacturer's literature, illustrations, specifications and engineering data.

- 6) Registers, grilles and diffusers.
- 7) Flexible connections.
- 8) Other technical data related to the specified material and equipment as requested by ENGINEER.
- 9) Duct sealants.
- 10) Deviations from Contract Documents
- 2. Performance Testing Plans and Procedures: Submit written performance test procedures for the following tests:
 - a. Odor Control System Field Tests.
 - b. Performance test of the overall Odor Control System.
- B. Informational Submittals: Submit the following:
 - 1. Test and Evaluation Reports:
 - a. Submit factory test reports.
 - 2. Site Quality Control Submittals:
 - a. Field Test Results: Submit a written report providing the results of the required field tests.
 - 3. Supplier Reports:
 - a. Submit a written report of the results of each visit by a manufacturer's serviceman, including purpose and time of visit, tasks performed and results obtained.
 - 4. Qualification Statements:
 - a. Ductwork manufacturer's qualifications.
 - b. Ductwork installer's qualifications.
 - 5. Design Data:
 - a. Other calculations, dimensions or materials related to the specified product as requested by ENGINEER.
- C. Closeout Submittals: Submit the following:
 - 1. Operation and Maintenance Manuals:
 - a. Submit complete installation, operation and maintenance manuals, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.
 - 1. CONTRACTOR shall be responsible for safe transportation, including all freight costs for delivery to the Site, procuring any necessary permits, handling, and open air storage of the adsorber, fan, pumps, chemical storage tanks and other materials purchased as specified in this Section.
 - 2. Odor Control Equipment shall be unloaded with care and stored in a location where they will be free from damage. Impact of a tool or other heavy object may result in

- damage and affect the service life of the odor control equipment and associated ductwork.
3. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.
 4. Pumps shall come completely assembled and protected against entry of foreign objects.
 5. Suction and discharge ports shall be protected against entry of foreign objects.
 6. Store equipment and materials so as to keep free from moisture, damage, and deterioration.
 7. Vessels shall be crated and installed on a shipping skid or saddles for ease of movement and protection during transportation.
 8. Openings shall be covered to protect flange surfaces and to prevent foreign materials from entering the vessels.
 9. Vessels and ductwork shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any tanks in transportation.
 10. Vessels shall be clearly marked for any precautions in handling.
- A. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.
- C. Store materials to permit easy access for inspection and identification. Keep all materials off ground, using pallets, platforms or other supports. Protect steel members and packaged materials from corrosion and deterioration.

1.6 GENERAL REQUIREMENTS

- A. The Drawings show general arrangement and extent of the Work to be completed, but the exact location and arrangement of all parts shall be determined as the Work progresses, to conform in the best possible manner with its surroundings. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions. Piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc. shall be located to clear such obstructions. Connections shown to the various units are intended as an indication only. The actual connections shall be made and to best suit each particular case, provide for expansion, circulation and minimize the amount of space required.
- B. Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall examine all the Contract Documents for conditions, which may affect the installation of their Work, and shall arrange their Work accordingly. Provide all required items to complete the systems to the extent required by the Contract Documents.

- C. If piping or ductwork can be run to better advantage, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete Shop Drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.

1.7 EQUIPMENT DEFECTS

- A. Equipment, which have mechanical defects and that do not meet vibration requirements, will be rejected and shall be replaced at CONTRACTOR'S full expense for furnishing, installing, removal, and replacement.
- B. Mechanical defects shall include excessive vibration, improper balancing of rotating parts, improper tolerances, binding, excessive bearing heating, defective materials, improper fitting of parts, and any other defect which will in time damage the equipment or impair its operation.
- C. Requirements shall be met concerning minimum and maximum dimensions and the specifications for materials. If it is found upon delivery that materials do not agree with the requirements of these Specifications as to size, type, quality, or metallurgy, they will be rejected as unfit for use in the Work.

PART 2 -PRODUCTS

2.1 PRODUCT AND MANUFACTURER

- A. General:
 - 1. All materials of construction shall be of corrosion resistant construction. The system shall be designed for continuous operation.
 - 2. The system shall be designed for a flow of 1000 cfm at a total pressure loss no greater than 9.0" wc. Blower shall operate at no greater than 3.0 BHP.
 - 3. This system shall have a removal efficiency of 98.5% for the effective life of the media when treating air containing 5-PPM hydrogen sulfide. Contact time shall not be less than 0.6 seconds.
 - 4. Touch up paint shall be provided.
- B. Vessel:
 - 1. Product and Manufacturer: Provide one of the following carbon drums:
 - a. Carbtrol Model G-11.
 - b. Or equal.
 - 2. The canisters shall be of linear polyethylene construction with removable lid. Wall thickness shall be approximately 5/16". Each canister (total of two) shall be 40" diameter by 48" high and shall contain 500 pounds of virgin carbon. Inlet and outlet connection shall be 8-inches in diameter. No handling of the media shall be required in the operation of this system.
 - 3. Each canister shall be individually removable. Each canister shall be equipped with a 3/4-inch diameter schedule 40-drain pipe with PVC shutoff ball valve. Contractor shall furnish and install 1-inch PVC condensate pipe

header to direct condensate from vessels to nearest floor drain in the Odor Control Room. Pitch condensate header 1/8" per foot to drain.

4. A grounding rod shall be provided in each media bed, which will be connected to an external grounding lug on the tank.

C. Interconnecting Ductwork:

1. All duct and fittings shall be constructed of Type 316 Stainless Steel. Ducts size shall be as shown on the Contract Drawings. All duct connections upstream of odor control fan shall be welded and all connections at all equipment and dampers and downstream of the odor control fan shall be flanged, gasketed and bolted.
2. Connections to the inlet and outlet of the odor control blower shall be made with flexible connectors and stainless-steel clamps.
3. CONTRACTOR shall provide all hangers, straps, anchors, and similar supporting devices to secure the duct to meet with the inlet and outlet of the odor control unit. Nuts, bolts, anchors, etc., shall be minimum Type 316 stainless steel. Support mechanisms shall be of corrosion resistant construction.
4. Where duct comes in contact with a supporting device, a minimum 1/4" thick neoprene pad shall be furnished to prevent damage to the duct.
5. Refer to specification 23 31 13 – Metal Ductwork.

D. Carbon Media:

1. The media provided shall be a coconut based granular virgin carbon. Carbon shall meet the following requirements:
 - a. Particle Type: Granular
 - b. Size(US Sieve): 4 x 8
 - c. CCL4 Activity: 60 to 65
 - d. Apparent Density (glee): .45 to .50
 - e. Moisture (%): 2
 - f. Hardness: 90

E. Analytical Services:

1. Media Sampling and Analysis
 - a. The manufacturer shall, after 3 months post start up, analyze media samples to predict the remaining service life of system media. Such service will be provided as needed at the manufacturer's expense.

F. Electrical Grounding System:

1. Vessel must be grounded prior to operation. A minimum size 8 AWG copper grounding cable shall be attached between the cable clamp provided on the vessel and the building electrical grounding system by the electrical contractor.

G. Performance Testing

1. General:
 - a. The testing shall consist of two components:

- 1) Verifying the system airflow rate being conveyed by the fan of the vessel. The air flow rate shall be determined to meet the specified rate, as documented in a report prepared by the testing and balancing firm, and accepted by the Engineer, before conducting the hydrogen sulfide removal performance test.
 - b. The performance of the vessel in removing hydrogen sulfide gas.
 - c. The Engineer shall be notified of the airflow rate measurement and hydrogen sulfide removal performance test dates two weeks in advance of each test.
2. System Airflow Rate:
- a. The measurement of the air flow rate shall be conducted by a testing firm certified by the NEBB (National Environmental Balancing Bureau), AABC (Associated Air Balance Council), SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) or approved equal by the Engineer.
 - b. The testing firm shall have a record of at least five (5) years experience in the testing and balancing industry, engaged in heating, ventilating, and air conditioning work. The testing firm shall submit biographical data on the employee proposed to directly supervise the testing, balancing and adjusting work.
 - c. The testing firm shall provide all labor, materials, equipment and incidentals required to perform the testing, adjusting and balancing necessary to meet the specified air flow rate of the Odor Control System.
 - d. All testing, adjusting, and balancing of the system shall be performed in compliance with the standard procedures manual published by the testing, adjusting, and balancing organization affiliated with the testing firm. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards of these organizations.
 - e. Submit a certified report outlining the procedure used to balance the system, the types of measuring devices used, and the results of the testing.
3. Hydrogen Sulfide Removal Performance:
- a. A protocol shall be submitted prior to the test, which outlines the procedures and the equipment that is to be used. A Professional Engineer shall sign the protocol.
 - b. Hydrogen sulfide gas shall be introduced into the ducting upstream of the adsorber to produce an inlet concentration at the inlet of the adsorber 5-ppmv +/-1-ppmv for a time period of 2 hours. The exhaust from the adsorber shall be measured in the downstream ductwork. The measurement upstream and downstream of the adsorber shall be conducted at locations that will produce a measurement representative of the inlet and outlet air stream. Measurements shall be made using devices with suitable accuracy and precision such as a Jerome meter, manufactured by Arizona Instruments, Inc.
 - c. Measurements shall be made every 10 minutes, or continuous recorders

- may be used.
 - d. The adsorber is required to remove 98.5% of the inlet concentration of hydrogen sulfide for the duration of test period. If this performance is not met retesting shall be conducted at the expense of the manufacturer. This will include the complete replacement of the media if the initial performance test fails to meet the performance specified.
 - e. A report documenting the procedures and test results shall be prepared and signed by registered Professional Engineer and submitted to the Engineer
- D. Hardware and Gaskets:
- 1. All hardware shall be Type 316L stainless steel. Gaskets shall be a minimum of 1/8-inch thick, full face, EPDM suitable for the intended service.
- E. Flexible Connectors:
- 1. A fan inlet flexible connector shall be included in the ductwork to dampen axial, lateral, and vibration duct movement. An additional flexible connector shall be installed at the fan outlet, as recommended by the fan manufacturer.
- F. Control Damper:
- 1. Refer to specification 23 31 13 – Metal Ductwork.

2.2 HYDROGEN SULFIDE METER

- A. Provide a hydrogen sulfide meter as manufactured by Jerome Industries, Model 631-X.
- 1. Features:
 - a. Accurate analysis of hydrogen sulfide in seconds
 - b. Rugged and easy to operate
 - c. Rechargeable internal battery pack for portability
 - d. Automatic backlight for LCD during low light conditions
 - e. Microprocessor to ensure a linear response throughout the entire range of the sensor
 - f. Survey mode for rapid source detection of hydrogen sulfide concentrations
 - g. Wide detection range allows multiple applications
 - h. Pressure sensitive membrane switch operation
 - i. Stable gold film sensor
 - 2. Specifications:
 - a. Resolution: 0.001 at Range 0 to 0.1 ppm at Range 3
 - b. Detection Range: 0.003-50 ppm
 - c. Precision: 5% Relative Standard Deviation
 - d. Accuracy: Range 0: ± 0.003 ppm at 0.050 ppm
 - e. Flow Rate: 150 cc/min or 0.15 l/min
 - f. Power Requirements: 100-120 V - 50/60 Hz, 1 A or 220-240 V - 50/60 Hz, 1 A

- g. Internal Battery Pack Rechargeable nickel-cadmium
- h. Environmental Range: 0-40 °C, noncondensing, nonexplosive
- i. Interfaces: RS-232 PC using JCI software
- j. Dimensions: 6" W x 13" L x 4" H
- k. Weight: 7 lb
- l. Warranty: One year, factory parts and labor.
- m. Certifications European Communities (CE) for 220-240 V-model only.

2.3 ODOR CONTROL EXHAUST FAN

- A. Refer to specification 23 34 06 – Non-Metallic HVAC Fans.

2.4 INSTRUMENTATION AND SYSTEMS CONTROLS

- A. Refer to specification 23 09 00 – Instrumentation and Control for HVAC.

2.5 SURFACE PREPARATION AND PAINTING

- A. Pumps, motors, drives, frames, baseplates, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09 91 00, Painting. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.
- B. Surface preparation and painting shall conform to the requirements of Section 09 91 00, Painting.
- C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.
- D. CONTRACTOR shall certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09 91 00, Painting.

2.6 TOOLS AND SPARE PARTS

- A. Provide manufacturer's recommended spare parts.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the Work is to be installed and notify the ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. CONTRACTOR shall furnish, install, and test the Odor Control System. Air balance of the Odor Control System is specified in Section 44 31 83, Adjusting and Balancing Odor Control Systems, and shall be incorporated as part of the Odor Control System and associated testing.
- B. Equipment shall be installed as specified herein, as shown, and in accordance with the manufacturer's recommendations and instructions. Equipment shall be installed in such manner that connecting piping will not impose any strain whatever on any equipment. Equipment shall be set upon grouted foundations, level or perpendicular, as the case may be, so that connecting flanges, screwed connections, or flexible connections will meet without strain or distortion. Base leveling nuts shall be blocked out during grouting of foundations, the grout allowed to set for not less than three days, leveling nuts loosened and followed by grouting of block-outs, with non-shrink grout as specified in Section 03 60 00, Grouting.
- C. Install the fans in accordance with the fan manufacturer's recommendations and instructions.
- D. All equipment shall be installed with Type 316L stainless steel anchor bolts as specified in Section 05 05 33, Anchor Systems.
- E. All equipment furnished under this Section shall be suitable for installation as shown and as specified herein. CONTRACTOR shall field verify locations, sizes and elevations for all connections. CONTRACTOR shall be responsible for determining the necessary clearances and headroom required to move all equipment to its final location.
- F. In every case where a drive motor is connected to a driven piece of equipment by a flexible coupling, the coupling halves shall be disconnected and alignment between motor and equipment checked and corrected. Machinery shall first be perfectly aligned and leveled by means of steel wedges and shims near anchor bolts. Anchor bolts shall be tightened against shims on wedges and equipment shall again be checked for level and alignment before placing grout.
- G. In general, checking and correcting the alignment shall follow procedures set up in the Standards of the Hydraulic Institute, Instructions for Installation, Operation, and Maintenance of Centrifugal Pumps. Equipment shall be properly leveled and brought into annular and parallel alignment.
- H. Equipment bases shall not be grouted nor foundation bolts finally tightened until all piping connections are complete and in satisfactory alignment with no strain transmitted to the equipment.
- I. Examine pads or supports to receive adsorber, fan, and pumps for:

1. Proper anchor bolt locations.
 2. Unevenness, irregularities and incorrect dimensions.
- J. Supervise installation in accordance with odor control components manufacturer's instructions and recommendations.
- L. Provide flanged flexible connections at air inlet and discharge of exhaust fan.
- M. All flexible connections with air handling equipment will be supported at both ends within 18-inches of joint.
- N. Installation and testing of pumps shall be in complete accordance with manufacturer's instructions and recommendations.
- P. All equipment shall be installed on concrete bases and secured with anchor bolts in accordance with the manufacturer's recommendations and as shown. Concrete bases shall be poured to an elevation to facilitate proper installation and access.
- Q. Provide 1-inch PVC pipe on each fan to convey leakage to nearest approved drainage point.
- R. Installation shall include furnishing and applying an initial supply of grease and oil, recommended by the respective manufacturers.
- S. Support piping independent of pumps.
- T. Connect all piping, valves and accessories as detailed on the Drawings, specifications, and approved Shop Drawings.
- U. Install all conduit and wiring and complete all connections.
- W. The carbon adsorber system shall be placed on concrete bases. Concrete work and grout are specified in Division 03, Concrete.
- X. Support piping independent of carbon adsorber system.

3.3 INSPECTION AND START-UP ADJUSTMENTS

- A. Perform the following inspection of equipment with the equipment manufacturer's approved representative: CONTRACTOR shall submit the Certification of Inspection to the ENGINEER.
1. Verify proper equipment mounting and setting.
 2. Verify that control fan, interlock and power wiring, each are complete and operational.
 3. Verify alignment of each motor and drive.
 4. Verify proper piping connections and accessories.
 5. Verify that lubrication has been completed.

6. Verify direction of rotation.
7. Verify setting of safety controls.
8. Monitor heat buildup in bearings.
9. Check motor loads against nameplate data.
10. Verify proper starter overload heater sizes.
11. Verify function of safety and operating controls.
12. Verify proper operation of equipment.
13. Verify proper chemical solution sump level.
14. Verify carbon levels and distribution.
15. Overall Odor Control System.

B. Start-up Adjustments:

1. Remove all loose materials and obstructions from interior of ducts and adsorber.
2. Remove debris and waste materials resulting from installation.
3. Adjust fan for proper alignment and flow.
4. Set volume control devices for approximate positions in preparation for final testing and balancing.
5. Balance system for CFM as shown, in accordance with this Section and as specified in Section 44 31 83, Adjusting and Balancing Odor Control Systems.

3.4 MANUFACTURER'S SERVICES

- A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visit to the Site for a period of 8 hours per visit. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be as described under Section 01821, Instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the Odor Control System conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
- B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.
- C. Serviceman shall verify that lubrication systems are complete, clean and filled with the proper grade of lubricants.

+ + END OF SECTION + +

++ NO TEXT ON THIS PAGE ++

SECTION 44 31 83

ADJUSTING AND BALANCING ODOR CONTROL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide an acceptable balancing company to perform the Work and furnish all labor, materials, equipment and incidentals required to perform the testing, balancing and adjusting herein specified. Interim and final testing and balancing shall be required for the Odor Control Systems.

B. Related Sections:

1. Section 44 31 19, Packaged Odor Control Systems.

1.2 QUALITY ASSURANCE

A. Balancers Qualifications:

1. Contractor shall engage an experience balancer to perform the work of this Section who has specialized in testing, adjusting and balancing for these type of systems.
2. Submit biographical data on employee proposed to directly supervise the testing, balancing and adjusting Work.
2. Submit proof of certification in the State of Connecticut to conduct air system testing and balancing and a record of at least five years experience in the mechanical contracting industry, engaged in testing and balancing of large commercial and industrial air systems.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Testing Plans and Procedures:

- a. Submit testing plan that complies with section 3.2 of this specification. Include certified report outlining procedure used to balance the system and the types of measuring devices used.
- b. Data Sheets: Submit data sheets on each item of testing equipment. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors.
- c. Report Forms:
 - 1) Submit specimen copies of report forms.
 - 2) Reports shall be on the balancing manufacturer's approved forms.
 - 3) CONTRACTOR shall sign and date each form in the space provided and proof of certification shall accompany the final report.

- B. Informational Submittals: Submit the following:
 - 1. Site Quality Control Submittals:
 - a. Submit 2 certified copies of required test reports to the ENGINEER.

1.4 JOB CONDITIONS

- A. Odor Control System shall be in continuous operation with all other system components and all Wastewater Treatment Plant processes operating as required to accomplish the testing, adjusting and balancing Work.
- B. Adjust dampers and blast gates to achieve specified airflows, as shown.
- C. Balance system for the interim and final Design Condition that shall be provided by the ENGINEER.
- D. Lock and mark all damper positions and leave entire system in balanced working order.

1.5 CORRECTIVE ADJUSTMENTS

- A. Should corrective measures of the Work be required, the retesting, or adjusting and balancing, shall be at no additional cost to the OWNER.

PART 2 - PRODUCTS

2.1 AIR BALANCE INSTRUMENTS

- A. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, etc., as may be required to perform all air balance tests of the completed Odor Control Systems.

2.2 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

- A. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the completed Odor Control Systems' performance.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the Work is to be installed and notify the ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

- B. Inspection:
 - 1. Verify proper equipment mounting and setting.
 - 2. Verify proper piping connections and accessories.
 - 3. Verify that lubrication is completed.
- C. First Run Observations: Verify setting of safety controls.
- D. Equipment Check:
 - 1. Verify function of safety and operating controls.
 - 2. Verify proper operation of equipment.
 - 3. Report on inspection, observation and checking procedures.

3.2 SYSTEM BALANCING

- A. Test, adjust and balance systems in accordance with the NEBB (National Environmental Balancing Bureau), or SMACNA's "HVAC Systems - Testing, Adjusting and Balancing". Balance the system to the airflow values shown. If the indicated flow values are not obtainable with the given fan output, provide the actual flows to be in proportion with those shown.
- B. Preliminary: Identify and list all air system branches to be tested. Each air system branch is defined as a single foul air take-off connected to the aluminum cover system, as well as the collection duct serving several individual foul air take-offs.
- C. Interim Balance:
 - 1. With all dampers fully open, determine airflow at each branch, and at the Odor Control System's fan inlets.
- D. Final Balance:
 - 1. Adjust branch duct dampers to proper design cfm. At each branch duct and under all aluminum cover systems, measure and record static pressure.
 - 2. Plug all holes in ductwork required for balancing with a removable plug, so as the OWNER may utilize same holes for future balancing and adjustments. Plugs shall provide air-tight seal. All holes drilled in FRP and exposing fiber shall be coated with resin.
- E. Verification:
 - 1. Prepare summation of readings of observed cfm for each system, compare with required cfm, and note the duct losses of each branch.
 - 2. Verify design cfm and pressure of the Odor Control System's fans.
 - 3. If the air systems are not properly balanced, CONTRACTOR shall rebalance and recheck all data in the presence of the ENGINEER and be approved by the ENGINEER.
- F. Labeling: Label the correct position of each flow-controlling damper by a permanent marker that will remain visible following painting. Acceptable markers are stainless

steel bolts drilled through the damper position indicating faceplate. Painted markers are not acceptable.

3.3 SYSTEM PERFORMANCE REPORT

- A. Test locations shall be as approved by the ENGINEER.
- B. Report of test results shall include original recording and two reproductions.

+ + END OF SECTION + +

SECTION 46 24 33

CHANNEL GRINDERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: The CONTRACTOR shall furnish all labor, tools, materials, equipment and incidentals required to provide two channel type grinders and channel support frames, complete and operational with control equipment and accessories, for mounting in a concrete channel as shown on the drawings and specified herein. Anchor bolts, expansion anchors and inserts are included in this Section. Grinder Control Panels shall be located as shown on the drawings.
- B. Responsibility: The grinder manufacturer shall furnish all components specified herein and shall be vested with unit responsibility for the proper function of the complete grinder systems including the grinder explosion proof motor, grinder control panel, channel support frame, and all appurtenances.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 05 33, Anchor Systems.
 - 3. Section 09 91 00, Painting.
 - 4. Section 40 60 05, Instrumentation and Control for Process Systems

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer shall have a minimum of 10 years of experience of producing substantially similar equipment and shall be able to show evidence of at least 5 installations in satisfactory operation for at least 5 years in the continental United States. Include reference lists, which are inclusive of contact names, phone numbers, application and length of service.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section from a single grinder equipment manufacturer.
 - 2. Grinder equipment manufacturer shall review and approve or shall prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically designed for grinding service and shall be integrated into the overall equipment design by the grinder equipment manufacturer.
- C. Source Quality Control:

1. Shop Test: Grinder and motor controller shall be factory tested to ensure satisfactory operation.
 2. Visual Inspection: Verify that equipment complies with Specifications and approved Shop Drawings.
 3. Packing:
 - a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
 - b. Protect machined surfaces and mating connections.
 - c. Protect bearings and gearing with a shop applied corrosion prevention coating.
 - d. Cover all openings into gear boxes with vapor inhibiting and water repellent material.
 - e. Adequately crate to prevent damage during shipment, delivery and storage.
 - f. Identify crate contents on packing slip fastened to outside of crate.
- D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. Standards of the Hydraulic Institute.
 2. American Gear Manufacturers Association.
 3. Anti-Friction Bearing Manufacturers Association.
 4. National Electrical Code (NEC).
 5. Underwriter Laboratory (UL and cUL).
 6. Standards of National Electrical Manufacturers (NEMA) Association.
 7. American National Standards Institute (ANSI).
 8. Standards of American Society for Testing and Materials.
 9. American Iron and Steel Institute.
 10. ASTM A536-77: Standard Specification for Ductile Iron Casting; AISI 303 Stainless Steel, AISI 204 Stainless Steel, AISI 4140 Heat Treated Hexagon Steel; AISI 4130 Heat Treated Alloy Steel; 45-50 Rockwell AC≡.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Product Data:
 - a. Manufacturer's literature, data sheets, fabrication, assembly and mounting drawings of the following components showing materials and significant dimensions in sufficient detail to demonstrate compliance with specified requirements.
 1. Housing:
 - a) Materials of construction.
 2. Shafts and Cutting Elements:
 - a) Diameter.
 - b) Materials of construction.
 - c) Seals.
 3. Gear Reducers:

- a) Materials of construction.
- b) Bearing ratings.
- c) Bearing life under maximum loading conditions.
- 4. Motors:
 - a) Horsepower.
 - b) Rpm.
 - c) Insulation and enclosure details.
 - d) Efficiency at full, 3/4 and 1/2 load.
- 5. Electrical Information:
 - a) Wiring diagrams showing all electrical connections to the motor and controls.
 - b) Drawings of control panels furnished in accordance with Section 40 60 05, Instrumentation and Control for Process Systems.
- 6. Weight of the complete assembly.

B. Informational Submittals: Submit the following:

- 1. Source Quality Control Submittals:
 - a. Submit results of Hydrostatic test.
 - b. Submit results of required control panel shop tests.
- 2. Site Quality Control Submittals:
 - a. Submit a written report giving the results of the required field tests.
 - b. Submit written report of the results of each visit by a manufacturer's serviceman, including purpose and time of visit, tasks performed and results obtained.
- 3. Support Design Information:
 - a. Weight of the complete assembly.

C. Closeout Submittals:

- 1. Operation and Maintenance Manuals:
 - a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

D. Maintenance Material Submittals: Furnish the following:

- 1. Spare Parts:
 - a. Furnish all required spare parts as specified in Part 2 of this specification.
- 2. Tools:
 - a. Furnish all required special tools as specified in Part 2 of this specification.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
- B. Storage and Protection:
 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- C. Acceptance at Site:
 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The grinders shall be electrically-driven and shall reduce solids to a size that will pass through the slot size specified.
- B. The grinders shall be flow-through type, installed in the influent channels to the wet well. The grinders shall be readily removable by removal of fastening devices only, without requiring demolition and repair of the concrete. CONTRACTOR shall provide a stainless steel lifting chain for removing the unit from the channel.
- C. The grinders shall operate automatically and continuously and shall be capable of operating satisfactorily at low or zero flows for extended periods.
- D. Service Conditions: The grinders shall conform to the following design criteria:
 1. Number Required: 2
 2. Minimum Flow (gpm): 590
 3. Maximum Flow (gpm): 7400
 4. Channel Width (in): 36
 5. Channel Height (in): 67
 6. Max Water Depth: (in): 45

2.2 DETAILS OF CONSTRUCTION

- A. General:
 1. The grinders shall be of two-shaft design and be capable of continuous

operation, processing wet or dry. Bar screens or single shaft devices utilizing a single rotating cutter bar with stationary cutters will not be acceptable. Individual cutters and spacers must be surface ground to the inside hexagon to a tolerance of 0.015 inch.

2. Two-shaft design consists of two parallel shafts alternately stacked with intermeshing cutters and spacers positioned on the shaft to form a helical pattern. The two shafts shall counter-rotate with the driven shaft operating at approximately two-thirds (2/3) the speed of the drive shaft.
3. Grinders shall include end housings, covers, shafts, side rails, reducer, torque motor, cutters, spacers, bearings and seals, and perforated screen drums.
4. Rotating perforated screen drums shall consist of cylindrical perforated sheet, support rings, and stub shafts. The rotating drums shall direct all solids towards and into the counter-rotating dual-shaft grinder. The drums shall be driven by the grinder drive mechanism.

B. Components:

1. Grinder:
 - a. Grinder end housings shall be cast of ASTM A536-84 ductile iron with a cast-in-place flow deflector, designed to protect the bushings while guiding particles directly into the cutting chamber.
 - b. Top covers shall be ASTM A536-84 ductile iron and bottom covers shall be ASTM A36 hot rolled plates.
 - c. Grinder drive and driven shafts shall be made of AISI 4140 Heat Treated Hexagon Steel with a tensile-strength rating of not less than 149,000 psi. Each hexagonal shaft diameter shall be a minimum of 2-inches.
2. Perforated Screen Drums:
 - a. The screen drums shall be made of 11 ga. 304 stainless steel sheet. The perforated sheet shall have 1/4-inch diameter holes on a 3/8 inch stagger.
 - b. The drum supports shall be constructed of 304 stainless steel. The end supports shall include stub shafts for the mounting of seal assemblies. Center support ring(s) shall provide additional structure to the center of the drums.
 - c. Drum stub shafts shall be made of 304 stainless steel with a tensile strength of not less than 95,000 psi. The shaft diameter shall be a minimum of 1-1/2 inch.
3. Side Rails:
 - a. The inside profile of the side rail shall be concave, with an adjustable UHMW plastic extension strip to minimize clearance at the front of the drums. This clearance shall not exceed 1/16 inch (1.6 mm) from the major diameter of the perforated screen drums.
 - b. Side rails shall be cast of ASTM A536-84 ductile iron.
4. Cutters and Spacers:
 - a. The inside configuration of both cutters and spacers shall be hexagonal so as to fit the shafts with a total clearance not to exceed 0.015 inch across the flats to assure positive drive and increase the compressive strength of the

- spacers.
- b. Cutters and spacers shall be AISI 4130 Heat Treated Alloy Steel, surface ground for uniformity and through-hardened to a minimum 45-50 Rockwell C.
 - c. Cutter configuration shall consist of individual 11 tooth cam cutters on both shafts. To maintain particle size, the height of the tooth shall not exceed 1/2-inch above the root diameter. Cutter to cutter root diameter overlap shall be not less than 1/16-inch or greater than 1/4-inch to maintain the best possible cutting efficiency while incurring the least amount of frictional losses.
 - d. The cutter shall exert a minimum of 450 lbs per HP continuously and 1,430 lbs per HP at momentary load peaks at the tooth tip.
5. Bearings and Seals:
- a. The radial and axial loads of the cutter shafts and coil drum stub shafts shall be borne by sealed, oversized, deep-groove ball bearings at each end.
 - b. The bearings shall be protected by a combination of a replaceable and independent tortuous path device and mechanical seals.
 - c. Face materials shall be of tungsten carbide to tungsten carbide.
 - d. O-rings shall be made of Buna-N elastomers.
 - e. Products requiring continuous or occasional lubrication or flushing shall not be accepted.
 - f. The mechanical seal shall be rated at 90 psi continuous duty by the seal supplier.
 - g. The bearings shall be housed in a replaceable cartridge that supports and aligns the bearings and seals, as well as protects the shafts and end housings. The seal elements shall be independent of the stack height; therefore cutter stack tightness shall not affect seal performance. The seal elements shall maintain their factory set preload independent of the cutter stack tightness.
 - h. Seals shall meet required pressure rating regardless of cutter stack fit. The seal cartridge shall provide seal protection against axial loading on shafts and bearings during shaft deflection.
 - i. Each seal element shall be positively locked to its corresponding rotating or static cartridge element. This positive lock on the seal elements is critical to long seal life in applications where grit or other abrasive materials are present.
6. Intermediate Shaft Support:
- a. An intermediate shaft support shall be provided in the center of the cutter stack.
 - b. The intermediate shaft support shall provide additional support for heavier than normal influent grinder demand loads and protection for the seal assemblies.
 - c. The intermediate shaft support shall be made of a cast 303 stainless steel collar and two bushings. The bushings shall act as bearings to allow the free rotation of the shafts.

7. Reducer:
 - a. The gear speed reducer shall be a grease-filled planetary type of reducer with "Heavy Shock" (500%) load classification. The reduction ratio shall be 29:1.
 - b. The input shaft of the reducer shall be directly coupled to the motor using a three-piece coupling, and the output shaft of the reducer shall be directly coupled with the grinder using a two-piece coupling.
8. Extended Shaft:
 - a. Provide an 18" shaft extension to increase the height of the motor above the water surface.
9. Motor:
 - a. The motor shall be rated for a Class 1, Division 1, Group D area and shall be 5-HP, explosion-proof, 1725 rpm, 460 volt, 60 Hz, 3-phase.
 - b. Motor service factor shall be 1.15, the efficiency factor not less than 85% at full load and the power factor not less than 80% at full load.
 - c. Motor shall be furnished with sufficient length of 7 conductor submersible cable for connection to an external junction box. Contractor to confirm length in the field.
 - d. Required Running Torque per Horsepower (kW):
 - 1) Continuously: 1000 in-lbs./hp minimum.
 - 2) At momentary load peaks: 3396 in-lbs./hp
10. Channel Support Frame:
 - a. Provide channel frame system to support the grinder in place in the channel. Channel frame system shall allow for easy removal of the grinder without the removal of the support frame attached to the concrete channel. Provide all required support angles and all anchorage devices. System shall be standard unit designed and fabricated by the grinder manufacturer for the proposed application.
 - b. Entire assembly, including anchors, shall be fabricated of type 304 stainless steel.

2.3 CONTROL PANEL

- A. General:
 1. Each channel grinder shall be provided with a dedicated Control Panel.
 2. Panel construction shall be explosion proof, rated for Class I, Division 1 environment, fabricated of 316 stainless steel suitable for wall mounting, and shall conform to the requirements of Section 40 60 05, Instrumentation and Control for Process Systems. Doors shall have hinges and corrosion-resistant latches.
 3. Factory test control panel prior to shipment.
 4. Furnish a 460-volt, 3-phase, 60 Hz power feeder to the control panel. Include a main disconnect, transformer(s), and circuit breaker load center for all 120 volt panel power requirements.
 5. Panel shall contain the following:

- a. Full voltage reversing motor starter with 120-volt control power transformer sized for all 120-volt requirements. Solid-state control logic shall be provided with fuse protection and shall shut down the motor and provide an alarm on motor overload (as specified below).
- b. Provide Programmable Logic Controllers that are used to perform the specified functions for each grinder. Provide one hand-held programming devices and a copy of the program, which will be turned over to the OWNER.
- c. Equip panel with a load sensing control, which shall sense high torque caused by grinder jam or overload. When this occurs, the grinder shall stop instantly, reverse its rotation to clear the obstruction, stop once again, and commence the forward or normal action. If the jam is cleared, the counting circuit shall reset after approximately 30 seconds. If the jam remains, the above procedure shall be repeated up to three times. After three cycles have occurred, the grinder shall shut down automatically and energize a fail alarm.
- d. Provide panel with Hand/Off/Auto switch, Reset pushbutton, and indicating lights for Grinder Running, Grinder Malfunction, Motor Overload, Power On and E-Stop for each grinder. All panel mounted devices to be heavy duty type conforming with Section 40 60 05. Run lights are to be red, malfunction and overload to be amber, power on light to be white. All lights shall be push-to-test transformer type.
- e. In Hand mode the grinder shall run. In Off, grinder shall not operate. When in Auto mode, the grinder shall run continuously.
- f. Provide SPDT contacts rated at 5A, 120 VAC for remote indication of Power On, Grinder Running, Malfunction, Motor Overload, Auto position at Hand/Off/Auto switch, and Emergency Stop. Each signal shall be individual per grinder supplied.
- g. Panel shall accept Emergency Stop push button conductors from a remotely located device for each channel grinder provided. Emergency Stop push button supplied by others. When activated, the grinder shall de-energize and shutdown.
- h. Panel shall have two 1-inch hubs at the top and two 1-inch hub at the bottom for conduit installation.

B. Components:

1. Control panel enclosure shall house the control devices, relays, terminal blocks, and reversing motor starter.
2. Control Devices
 - a. Control devices that are mounted in the front panel of the enclosure shall be labeled with matte finished modified acrylic laminate labels.
 - b. Indicating lights shall be integral push-to-test transformer type with low voltage life 6 volts lamps.
 - c. Lamps and pushbuttons shall be heavy duty type. Pushbutton and selector switch contacts shall be rated NEMA A600.
3. Relays:

- a. Control relays shall be equipped with a 120-volt operating coil and 10 amp 240 VAC (resistive load) from "C" dry contacts. Contacts shall be wired to the terminal strip for easy field wiring.
 - b. Thermal overload relays shall have one (1) normally closed contact and one (1) normally open contact to signal a failure. The overload relay shall detect single phase and phase unbalance with the motor full load amps (FLA) adjustable so that the range selected includes the FLA rating and service factor.
- 4. Terminal Blocks:
 - a. Terminals for control and power wiring shall be provided for all field connections. A compression clamp of hardened steel shall grip the conductor on the connector bar captive and hardened steel screws shall tighten the compression clamp without touching the wire conductor. Terminals shall be vibration proof and fully shielded. Terminal blocks shall be suitable for wire sizes from 22 to 10 AWG. Terminal block bodies shall be molded of flea retardant polyamide type 6/6 nylon. Each terminal shall be individually labeled.
 - b. Power terminal blocks shall be strap screw type suitable for wire sizes from 22 to 8 AWG. Each terminal shall be individually labeled.
- 5. Wiring:

The AC power wiring shall be minimum No. 12 AWG gauge black; control wiring shall be No. 14 gauge red; neutral wiring shall be No. 16 gauge white. All wires shall be XHHW with 600 volt 90 degree C rating and have machine printed self-laminating labels.
- 6. Reversing Motor Starter:

Controller shall be equipped with NEMA Size 1 full voltage motor reversing starter with a 120 volt operating coil and captive terminal screws. The adjustable self-contained heater with thermal OL relay shall be class 10 and mounted directly to the contactor. OL relay shall be sized to the motor full load amperage. Forward and reverse contactors on the starter shall have both mechanical and electrical interlocks.

2.4 PRODUCT AND MANUFACTURER

- A. The Channel Grinders and appurtenances shall be the model listed below, manufactured by J.W.C. Environmental.

	<u>Model No.</u>
Channel Grinder	CDD5010-XD2.5

2.5 SHOP PAINTING

- A. Clean and prime ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 09 91 90.

2.6 ANCHOR BOLTS

- A. Furnish anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturer. Provide hooked anchor bolts for direct embedment during placement of concrete. Anchor bolt material shall be 304 stainless steel conforming to requirements of Section 05 05 33.

2.7 SPARE PARTS

- A. Furnish and deliver the following boxed and labeled:
 - 1. 100 percent replacement seals for (1) machine.
 - 2. 100 percent replacement cutter cartridges for (1) machine.
- B. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part.

2.8 LUBRICANTS

- A. Furnish lubricants, oil and grease as required for initial operation. Products shall be as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with approved Shop Drawings, manufacturer's recommendations, and as shown and specified.
- B. Lubricate equipment as recommended by the manufacturer.
- C. Check, align and adjust all equipment.

3.2 FIELD PAINTING

- A. Field painting shall conform to the requirements of Section 09 91 90.

3.3 START-UP AND FIELD TEST

- A. CONTRACTOR shall verify that all components of the grinder equipment and appurtenances, including controls, are compatible.
- B. CONTRACTOR shall conduct a functional field test of grinder and appurtenant equipment to demonstrate that each part and all components together function

correctly. CONTRACTOR shall provide all testing equipment required.

- C. CONTRACTOR shall make adjustments required to place the system in proper operating condition.
- D. CONTRACTOR shall test and operate the system and verify that the grinder and appurtenant equipment will operate continuously without vibrating, jamming or overheating and perform its specified function satisfactorily.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Furnish the services of a qualified factory-trained service representative from the manufacturer to assist in the installation of the equipment, check the installation before it is placed into operation, assist in the performance of field tests, supervise initial operations, and instruct plant operators in the care, operation, and maintenance of the equipment. A certificate from the manufacturer relative to these services is required under Section 01 75 11. The representative shall revisit the job site as often as necessary to place the equipment in proper working order, supervise testing and initial operations.
- B. Field Reports: Submit a report by manufacturer of each visit to the site. Reports shall provide complete information on time, schedule, tasks performed, persons contacted, problems corrected, test results, training, instruction and all other pertinent information and facts.

3.5 TRAINING

- A. In addition to above requirements, furnish services of a qualified factory trained operations and maintenance service representative to instruct and train plant operators in the proper care, operation and maintenance of equipment in accordance with the requirements of Section 01 79 23.

++ END OF SECTION ++

++ NO TEXT ON THIS PAGE ++