ADDENDUM A

Supplementary Terms and Conditions

This Addendum A and the corresponding Exhibit A together comprise the project specific requirements that are supplementary to the requirements of the Fermilab Subcontract General Provisions contained in FL-1 and the Fermilab Construction Subcontract Terms and Conditions contained in FL-3.

Project Information

Project Name: Mu2e Conventional Facilities
FESS/Engineering Project No. 6-10-2
Issue Date: February 17, 2014

Fermilab Project Team

Construction Manager:
Tom Lackowski

Fermilab Construction Coordinator:
Ronald Foutch

Fermilab ES&H Coordinator:
John Cassidy

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Drawings/Specifications

"**Preface to Addendum A for Mu2e Conventional Facilities (6-10-2) and MC Beamline Enclosure (6-10-22)**

The Mu2e Conventional Facilities, project number 6-10-2 and the MC Beamline Enclosure, project number 6-10-22 will be issued and managed as one subcontract.

The technical aspect of the two projects will remain as indicated in the original Request for Proposals (RFP) including the issued amendments. The technical specifications for each project remain specific to that project. The following addresses modifications to the two Addendum A's for the prosecution and management of the work."

1.0 Site Location

The Project is located on the Fermilab site in Batavia Illinois at the intersection of Kautz Road and Giese Road, in Kane County.

2.0 Scope of Work

The Mu2e Conventional Facilities, project number 6-10-2 and the MC Beamline Enclosure, project number 6-10-22 will be issued and managed as one subcontract. The initial Notice to Proceed (NTP #1) is planned to be issued in mid to late October 2014 and will obligate approximately 35% of the total initial subcontract price. The second NTP (NTP#2) is planned for mid to late February 2015 and will obligate all but approximately 8% of the total initial subcontract price. The final NTP (NTP#3) will obligate the remainder of the original subcontract amount in late October 2015. Supplemental agreements for agreed changes will be issued as the changes occur. The intent of combining the work into a single subcontract is to achieve the Beneficial Occupancy of the work scope associated with the MC Beamline Enclosure at the earliest possible date and to maintain the planned schedule duration of the construction while at the same time reducing the amount of paperwork associated with the management of the subcontract.

The Mu2e Conventional Facilities will construct the Mu2e Detector Hall, an industrial-type structure with a built up roof and metal siding on a braced structural steel frame system, and a cast-in-place reinforced concrete structure under the majority of the building. The building and below grade areas are outfitted to provide the environment to construct, support and operate, the scientific equipment that comprise the experiment. The Subcontractor's scope of work is in no way limited to the general work outline described below. The Subcontractor shall perform all work required to complete the construction work in strict accordance with the drawings and/or specifications. The description and quantities listed below are general in nature and are only intended to describe the range and complexity of this scope of work. They are not to be used as the basis for establishing a cost proposal. Specific quantities and definitions of the scope of work for bidding purposes shall be based solely on estimates developed by the Offeror from the drawings, specifications, Exhibit A and information obtained from examination of the Project site.

a. Significant figures of merit include:

i. Six (6) acres of site work;
ii. 80,000 to 90,000 CY of excavation and backfill;
iii. Six thousand (6000) CY of structural reinforced concrete;
iv. One hundred and ten (110) tons of structural steel and miscellaneous metals;
v. Installation of two 30 ton overhead bridge cranes;
vi. One (1) Hydraulic elevator;
vii. Mechanical and electrical services for 28,000 SF of floor area.

b. Environmental Protection, Erosion Control including adherence to the Project-specific Storm Water Pollution Prevention Plan (SWPPP) attached in Appendix D of this document. The SWPPP, along with Notice of Intent (NOI) has been submitted to the IEPA by Fermilab for a Project specific permit issued under the Laboratory's General NPDES Permit No. ILR10, issued from the IEPA to Fermilab for construction site activities. No earthwork will be permitted to commence until the Subcontractor has reviewed, formally accepted and signed the SWPPP. Included in the erosion control scope of work is the installation and maintenance of all control devices, soil stabilization and all other requirements of contract documents. All sub-tier sub-contractors are required to sign and adhere to the provisions of the SWPPP.

c. Protection of Existing Structures, utilities, roads, existing erosion control measures, temporary overhead power lines, survey monuments, and the work of other concurrent subcontracts.

d. Traffic Access and Control with barricades, barriers, signage, flaggers, temporary fencing, including maintenance of continuous two-way traffic on South Booster Road and Giesse Road.

e. Field Survey including temporary monuments, layout lines and grade stakes extended from Fermilab-furnished control points. Subcontractor shall also survey all interfacing structures and utilities, and immediately notify the Fermilab Construction Coordinator (FCC) of any discrepancies.

f. Surface Water and Drainage Control including protection of openings and open ends of interfacing structure to prevent flooding, regrading of existing swales and ditches, diversionary ditches at the base of stockpiles, swales, ditches, berms, culverts, site grading and dewatering systems such as temporary sumps, pumps and hoses.

g. Maintenance of Site Roads, including removal of earthen material, regrading, daily dust control when directed by the FCC. Snow removal along Giesse and South Booster Roads will be accomplished by Fermilab Roads and Grounds after the main site roads and parking lots have been cleared. The Subcontractor should be prepared to clear snow from his work sites and those portions of the roads requiring access during snowfall or immediately after a storm.

h. Establishment of Subcontractor's Area including hardstand, access drives, culverts, designated personnel parking areas and storage areas with approval of the FCC. Site preparation including the clearing and grubbing, stripping and segregation of the top soil, general site grading, and removal of a portion of Kautz Road and the removal of part of the adjacent stockpile area as needed for the excavation for the construction or as shown on the plans and drawings. Work scope includes access road to the site, worker parking areas, equipment and material storage areas and set up of optional office trailer.

i. Off-Site Disposal of all demolition and grubbing debris, unsuitable material, trash and waste material including proper receptacles for the daily collection of trash and waste to be disposed of off-site shall be subject to inspection and survey by Fermilab personnel for possible contaminants. Material found to be unsuitable for off-site disposal shall be segregated in a stockpile on the Fermilab site as determined by the FCC.

j. Designated Concrete Truck Wash-Out sites, as directed by the Fermilab Construction Coordinator and enforced by the Subcontractor.

k. Temporary Power for the subcontractors use at no cost can be extended from the 200 Amp. / 480V 3-phase fused disconnect on the exterior of the AP-10 transformer. The subcontractor can pick up and use Fermilab power poles, 3-phase electrical conductor, single phase 13.8KV to 480V pole mounted transformers from the Fermilab Railyard. The subcontractor is responsible for terminations, splices and disconnects. Also included is the removal and return to the Railyard of all Fermilab components.

l. Excavation and Trenching for utilities including removal, stockpiling and replacing with granular and soil materials as required.

m. Demolition of items shown on the plans such as power duct bank, asphalt road, sanitary lift stations, cast in place concrete walls and enclosures.

n. Underground Water Distribution System extensions including industrial cold water (ICW), domestic water supply (DWS), chilled water (CW) supply and return, and gravity sanitary sewer, including fittings, flanges, hot-taps, valves, valve boxes, trenching, bedding, thrust blocks, tie-rods, backfill, connections to existing segments of like systems, flushing, disinfection and testing.

o. Underground Power and Communication Distribution System, consisting of reinforced concrete encased PVC conduit, direct- buried rigid steel conduit, precast concrete manholes, collars, frames, covers, pull ropes, trenching, forming and color topping.

p. Excavation for structures including the slope stability design by a licensed Professional Engineer for excavations of depths greater than 20 feet. Backfill of structures with granular and suitable soils to the specified density.

q. Cast-in-Place Reinforced Concrete including spread and strip footings, foundation walls, piers, pilasters, grade beams, retaining walls, slabs on grade, equipment pads and foundations, oil containment structures, aprons and stoops including forming, joints, chamfers, sealants and curing.

r. Penetrations between underground enclosures and service buildings including low conductivity water (LCW) carrier pipes and PVC conduit penetrations. LCW piping is not included in this scope.

s. Hardstand Construction including new crushed stone hardstand areas and access drives including excavation, grading and compaction.

t. Structural Steel framing including columns, crane beams, roof beams, purlins, girts, bracing, brackets, framing around openings and connections.

u. Miscellaneous Metal including embedded steel shapes, pipe handrail, crane rail, rail accessories, pipe sleeves, embedded channel inserts, track plates, ladders, grating, bumper posts and equipment supports.

v. Metal Roof Decking

w. Pre-finished Metal Siding including matching scuppers, downspouts, louvers, corners, fascia, trim, caps, flashing and accessories.

x. Insulation including extended polystyrene for foundation walls, composite rigid foam board for the roof, and safing for miscellaneous joints and openings.

y. Roofing System including 4-ply built-up fiberglass felts, gravel surfacing flashing, coping, cant strips and sealants.

z. Moisture Protection, including caulking and sealants.

aa. Hollow Metal Doors and Frames including hardware.

bb. Insulated Steel Roll-up Doors complete with frame, trim, hardware and operators.

cc. Aluminum Store Fronts including trim, double glazing and doors.

dd. Concrete Masonry Units for interior partitions and exterior wall backup including mortar and reinforcing.

ee. Painting including all masonry walls, interior concrete walls, exposed structural steel, doors and frames, and miscellaneous metals.

ff. Ceramic Tile including wall and floor tile in the toilet rooms.

gg. Acoustical Ceiling System including suspension system and ceiling panels.

hh. Toilet Accessories including grab bars, dispensers, mirrors and shelving.

ii. Bridge Crane Installation, including partial assembly, rail alignment, installation of mainline conductor and load testing.

jj. Hydraulic Elevator complete with cylinder, jacking piston, guide rails, pump assembly, cab, and hoist way doors.

kk. Dedicated Outside Air System for Absorber area with side stream desiccant unit including complete installations, accessories, controls, sensors, ductwork, duct accessories, insulations, equipment/duct supports, balancing, start-up , testing and commissioning.

ll. Computer Air Handler (CRAH) system for the DAQ room, with chilled water coil, and specified accessories, including complete installations, ductwork, controls, sensors, balancing, start-up , testing and commissioning.

mm. Air handlers with chilled water coil and natural gas duct furnaces serving the high bay, solenoid power supply room, lower detector solenoid, and planning room, including complete installation, accessories, controls, sensors, ductwork, duct accessories, insulations, equipment/duct supports, intake louvers, control dampers, pressurization system, relief, balancing, start-up, testing and commissioning.

nn. Split system HVAC for the elevator room, complete ventilation system for the mechanical room, natural gas unit heaters, ceiling fans, electric unit heaters, baseboard, and cabinet unit heater, including controls, balancing, start-up, testing and commissioning.

oo. Make up air unit and corresponding exhaust fans for the ODH –purge systems, including start-up, and testing.

pp. Building Utility and process piping such as natural gas, glycol chilled water, non-glycol chilled water, domestic water and industrial cooling water (ICW), including gas meters, water meters, softener, gas regulators, glycol makeup system, pumps, expansion tanks, air separators, strainers, valves, and other specified accessories.

qq. Complete commissioning as specified and in accordance with the commissioning plan.

rr. Building flush out in accordance with the indoor air quality plan.

ss. Plumbing including complete installation, testing, start-up, fixtures, sump pumps, under drains, water meters, softeners, insulations, and other specified accessories

tt. Fire Suppression System including wet sprinklers, pre-action valve for dry pipe sprinklers, riser assembly, and portable fire extinguishers.

uu. Fire Detection and Alarm System including addressable control panel, line type heat detection panel, smoke detection and heat detection, and voice alarm system capable to interface with Fermilab' s site-wide emergency warning system. Includes connection of MC Beamline fire detection and alarm system to the Mu2e addressable control panel.

vv. Primary Power Systems including installation of Fermilab-furnished 1500 kVA and 750 kVA, 13.8 kV-480/277V, 3-phase oil-filled transformers, 13.8 kV , 600A 4-way air switches and one 13.8 kV, 600A fused 3-pole switch, Fermilab supplied 15 KV cable, terminations and testing of 13.8 kV power connections from buried in duct power line to conventional power transformer at each service building.

ww. Secondary Power Distribution including installation of Fermilab-furnished 2000A switchboard and, furnishing and installing 1200A switchboards, panelboards, transformers, 480V wiring, conduit and testing. Work also includes disconnection of temporary 480V service to beam enclosures.

xx. Power Distribution including single, duplex and quadruplex receptacles, disconnect switches, welding outlets, connections to mechanical equipment, pull boxes, and surface mounted, embedded and underground conduit, and wiring. Work includes specific location of electrical equipment and conduit within building to reserve space for future technical components and cooling water systems.

yy. Grounding Systems including driven copper ground rods, solid copper wall or slab penetrations, bare copper ground cable, copper bar grounds and connections. Work includes grounding system for substation and equipment, and the connection to the existing underground enclosure grounding system at each service building.

zz. Lighting Systems including incandescent and fluorescent fixtures for normal and emergency circuits, emergency lights with battery packs or UPS, exit fixtures, exterior fixtures, lamps, panelboards, conduit and wiring.

aaa. Cable Trays including ladder-type cable trays, supports, and accessories.

bbb. Electrical Testing of all systems.

ccc. Clean-Up, hauling away of all excess stockpiles, final grading and dressing of hardstands and access roads, removal of subcontractor's hardstand(s) and erosion control devices, landscape seeding, completion of punch list items and submission of as-built drawings and O&M manuals.

3.0 Items Affecting Work Planning

a. FUNDING LIMITATIONS

Presently only partial funds and authority are available for this subcontract. It will be funded in three (3) phases, corresponding to NTP #1, NTP #2 and NTP #3. The Mu2e Conventional

Facilities is a portion of a major congressional line item and will be authorized by NTP #2. The authority to obligate these construction funds is expected on or about mid- January, 2015. After receipt of this authorization, Fermilab plans to authorize and fund this work scope into the subcontract by issuing NTP #2. The majority of the funding of the subcontract will be authorized by NTP #2. In Phase III, the remainder of the funding will be released via NTP #3, which is expected near the end of October, 2015.

The Government's obligation under this subcontract is contingent upon the availability of appropriated funds from which payment for subcontract purposes can be made. No legal liability on the part of the Government for any payment may arise until funds are made available to Fermilab for this subcontract and until the Subcontractor receives notice of such availability, to be confirmed in writing by the Fermilab Procurement Administrator.

Notwithstanding, the incremental funding feature of the proposed subcontract, offerors must provide a proposal for the complete performance of all work, the sum of Phase I, Phase II and Phase III, called for in this solicitation, and the proposal prices must reflect this complete performance."

b. The "MC Beamline Enclosure", Project number 6-10-22, is located adjacent to the Mu2e Conventional Facilities Project and constructs a cast-in-place concrete enclosure that extends from the Delivery Ring to both the MC-1 building and to the Mu2e Detector Building. The two Projects are scheduled to start within days of each other. Because of the proximity and potential for interferences between these separate and distinct Projects Fermilab has decided that a single Subcontractor will be awarded both subcontracts. The Subcontractor shall coordinate work between the two subcontracts to mitigate any construction activity or weather related impact affecting the other Project. There will be a common SWPPP for the two Subcontracts.

c. The MC Beamline Enclosure Project will be completed and Fermilab will take occupancy of the enclosure several months prior to the completion of the Mu2e Conventional Facility Project. When the MC Beamline Enclosure is complete systems will have been energized with temporary power. Specifically stated or not the Subcontractor shall remove the temporary power connections and energize with the permanent power sourced from the Mu2e facility.

d. The Industrial Cool Water (ICW), Domestic Water (DWS) and the high pressure Natural Gas (Gas) piping that is rerouted around the building and excavation requires minimal service interruption that does not exceed one (1) day in duration for each utility.

e. Maintaining the concrete grades and alignment is critical to the installation and operations of the scientific equipment. Fermilab will secure the services of an independent surveyor to perform quality assurance on the alignment of the concrete base slab and walls. The Subcontractor shall allow access to the work area for these survey activities. Coordination of the survey quality assurance activities will be through the FCC. In general, critical areas below grade will be checked after the Subcontractor has established the layout lines and for some items, will be checked again after forms are erected, and again after form removal. The FCC will inform the Subcontractor of any non-conformance with the specifications which is to be corrected prior to additional concrete placement.

f. Setting of track plates and placing of the concrete topping slab shall not occur until the building is weather tight and temperatures can be maintained between 55 and 75 degrees Fahrenheit.

g. The Fermilab supplied Absorber steel will not be available until mid-January 2015.

h. All workers shall be required to take the Fermilab Orientation Training and the Fermilab General Employee Radiation Training (GERT) prior to working in the field. Each of these training classes are approximately ½ hour and will be arranged through the Fermilab Construction Coordinator.

i. Workers that will handle any radioactive materials shall take and pass the Fermilab Radiological Worker Classroom and Practical Factors Training. This training is approximately 8 hours in combined duration and will be arranged through the Fermilab Construction Coordinator.

3.2

1. Erosion Control Structures:
   a. Subcontractor shall have all required erosion control devices required by the SESCP or SWPPP and as shown on the drawings, in place prior to commencing any work for which they are required.
   b. As the work evolves, additional interim control structures may be required in order to protect waterways and/or comply with permit terms and conditions.
   c. Costs for installation and maintenance of these structures shall be considered incidental to the Project and included in the original proposal.
   d. The Subcontractor shall install all such structures within 24 hours of notification by Fermilab.
2. Maintenance of Erosion Control Structures:
   a. Subcontractor shall be required to perform inspections of all control structures as specified in the drawings and to maintain all control devices until final stabilization of all disturbed areas.
3. Temporary and Permanent Seeding and Stabilization
   a. The Subcontractor shall be required to follow seeding dates and requirements as specified and in accordance to the Illinois Urban Manual.
   b. The Subcontractor shall be responsible for providing appropriately vegetated surfaces as outlined in the Exhibit B or specified on the drawings
   c. The Subcontractor shall be responsible for establishing sufficient final vegetation required for stabilization as accepted by Fermilab before the erosion control structures may be removed. Any permanent seeding operations completed at the end of the growing season shall be carried out per dormant seeding requirements (Illinois Urban Manual Standard 880C)
   d. Subcontractor shall be required to maintain seeded areas into the following growing season until vegetation growth reaches 80% coverage.
   e. The Subcontractor shall not remove erosion control structures until final acceptance of vegetation by Fermilab. If the conditions do not allow for the removal at the time of final

acceptance, the Subcontractor shall remove the erosion control structures at no additional cost at a later date determined by Fermilab.

3.5 Identification Badging & Subcontractor Employee Orientation

Subcontractor and sub-tier Subcontractor's employees will be required to have Fermilab's ID badges.

3.6 Materials Furnished by Fermilab

The following list of materials and equipment will be provided by Fermilab for installation by the Subcontractor:

a. Overhead bridge cranes: Two 30 ton overhead bridge cranes will be delivered from a vendor to be off-loaded, erected, made operational, and tested by the Subcontractor. The cranes will be installed on common rails and energized by a common mainline conductor. Total approximate weight of each crane is 49,000#.
   i. Each crane will be delivered in five (5) major components (end trucks (2), girders (2 one with foot walk), built up trolley/hoist assembly (1)) plus the necessary hardware and equipment for complete cranes.
      1. The main line conductors and their support brackets will be furnished with the crane.
   ii. Technical Support from crane vendor for two (2) days on each crane plus one day during load test at no cost to the subcontractor.
   iii. The steel and concrete test weights required for load testing the crane totaling 37.5 tons are located at the Railyard Storage Area. The Subcontractor shall be required to pick up and return the test weights and provide for loading and off loading at the Railyard Storage Area. Fabric slings with the required length and capacity for lifting the test weights shall be provided by the subcontractor. The Subcontractor shall also provide all other required rigging including softeners.

b. Temporary Power Equipment: Subcontractor may elect to install and remove temporary power form the AP-10 transformer using Fermilab supplied equipment as listed:
   1. 480/277, 3-phase, 200 amp fused disconnect. (The subcontract may replace the existing fused disconnect and replace with a larger fused disconnect up to 600 Amps. for their convenience, This disconnect may be removed at the end of the project and holes sealed on transformer)
   2. Up to 12 Wood Poles for overhead electrical lines, 50 foot class 2.
   3. All other materials and equipment shall be provided by the Subcontractor.

c. One (1)pad-mounted 1,500 kVA, 13.8 kV-480/277V, 3-phase Oil-filled transformers weighing approximately 15,000 pounds. The Subcontractor will be required to load and haul the transformers from the Fermilab Railyard.

d. One (1) pad-mounted 750 kVA, 13.8 kV-480/277V, 3-phase oil-filled transformers weighing approximately 8,000 pounds. The Subcontractor will be required to load and haul the transformers from the Fermilab Railyard.

e. One (1) 2,000A, 480V switchboards measuring approximately 48" wide by 24" deep by 92" high and weighing approximately between 800 and 1,500 pounds. The Subcontractor shall be required to remove, load and haul switchboard from the storage location at the D0 service building.

f. One (1) motor driven 15KV, 600Amp pad mounted, metal enclosed switch with fuses approximately 36” x 62” x 95” tall, weighing approximately 2000 pounds. This switch shall be pick-up and transported from Fermilab Railyard.

g. Two (2) 15 KV 600A, 4-way air switches as manufactured by S&C Electric, each weighing approximately 1800 pounds to be pick-up and transported from the railyard by the Subcontractor.

h. 750 MCM, 15kV, EPR, insulated triplexed aluminum cable. Cable is supplied on reels as follows:
    i. 1681 feet (+2%, -0%); Reels: approx. 108” x 60” x 56”
    ii. Cable will be located at the Fermilab rail yard. Cable is to be loaded, transported and unloaded by Subcontractor. Unused cable is to be returned to railyard by Subcontractor.
    iii. See the Subcontract drawings for the quantities of Fermilab furnished transformers, cable and 15kV air switches.

i. Fermilab will supply the steel, support beams and air cooling manifold for the Proton Absorber. (See Drawing SC-38)
    iv. Steel plates; 10 plates 60” wide x 60” high x 8” thick weighing between 8500 and 9500 pounds. The plates may be Radioactive Material Class 1 (Exposure Rate < 1 mR/hr).
    v. Each steel plate will be prepared by Fermilab. There will be two plates welded to the sides with holes for threaded rod used during assembly, and two (2) drilled and taped holes on top of the plates for the McMaster –Carr hoist ring with 1”-8 thread and 2 3/16” embedment, 10,000 pound capacity. Fermilab will provide (loan) hoist rings for the subcontractors use.
    vi. Steel manifold assembly, 14” in diameter, for connection, using a flanged connector, to subcontractor’s supplied steel duct piping to be embedded in concrete base under absorber steel.
    vii. Fermilab alignment will verify the line and grade layout for the blocks prior to stacking. The bottom plates shall be set to within .25 inches of the specified grade. The subcontractor is to shim and grout solid to achieve this tolerance.
    viii. The steel plates shall be ready for pick-up within 170 calendar days of Notice to Proceed.

ix. The steel plates shall be pick-up and transported to the project by the Subcontractor from a location within four (4) miles on the Fermilab site. Fermilab will assist in loading the steel blocks via the buildings using the labs overhead crane and lifting slings. The subcontractor shall provide any cribbing and lifting slings required.

k. The following table provides the availability dates and other information on the Fermilab supplied materials listed above:

Nomenclature	Qty.	Value	Serial #	Date Material will be available (Based on 6-10-2 NTP)	Comments
30 Ton Overhead Crane	2	$300K to $500K	TBD	300 CD after NTP	RPF to be issued to crane manufacturer: See Addendum A, Scope of Work.
Temporary Power Equipment	as required	$50K	NA	At NTP	Used
1500 KVA Transformer	1	$120K	#8660022622	At NTP	Used
750 KVA Transformer	1	$40K	TBD	200 CD after NTP RFP to be used	RFP to be issued: See Addendum A, Scope of Work.
2000 Amp Switchboard	1	$8K	#A945293	At NTP	Used
Motor Driven 15 KV, 600 Amp Switch	1	$22K	TBD	200 CD after NTP	RFP to be issued: See Addendum A, Scope of Work.
15KV, 600 amp 4-way switch	2	$36K	TBD	201 CD after NTP	RFP to be issued: See Addendum A, Scope of Work.
750 MCM 12.5kv EPR triplexed cable	1650	$49K	NA	150 CD after NTP	RFP to bbe issued: See Addendum A, Scope of Work.
Proton Absorber steel	10	$250K	NA	151 CD after NTP	Fabricated by Fermilab
Proton Absorber air manifold	1	$5K	NA	152 CD after NTP	Fabricated by Fermilab

3.7 Buy American Act

Fermilab maintains a preference for domestic construction material. In accordance with Section 25 of FL-3, Fermilab Construction Subcontract Terms and Conditions, the following construction material or components are exempt from the Buy American Act:

There are no anticipated exemptions for this Project.

3.8 Services Furnished by Fermilab

The following services will be provided by Fermilab:

3.8.e – Electrical Power

Fermilab will provide electrical power at no charge to the Subcontractor.

3.8.f – Drinking Water

Fermilab will not provide drinking water for this Project and shall be provided by the Subcontractor.

3.8.g – Toilet Facilities

Fermilab will not provide toilet facilities for this Project and shall be provided by the Subcontractor.

3.12 Parking and Staging Area

Subcontractor shall provide for parking, trailers and staging areas for this project to the west of Giesse Road and north of the future beam line, as shown on the drawings.

3.14 Off-Site Disposal

a. No regulated waste is anticipated for this Project
b. Subcontractor shall submit recycling data from vendor.

4.1 Subcontractor's Safety Representative Responsibilities

a. For this project a Project Manager that is dedicated to the successful completion of the work is required. This position is not necessarily full time nor does his/her office need to be on site. The Project Manager may function for both the Mu2e Conventional Facilities, project number 6-10-2 and the MC Beamline Enclosure, project number 6-10-22.
b. For this Project the Superintendent cannot serve as the Subcontractor's Safety Representative for the day to day ES&H oversight. The Superintendent may function for both the Mu2e Conventional Facilities, project number 6-10-2 and the MC Beamline Enclosure, project number 6-10-22.
c. Safety Representative: When Subcontractor's daily trade headcount exceeds 20, the Subcontractor shall engage one on-site, full time Safety Representative as defined in Exhibit A section 4.1, Subcontractor's Project Team. This person may not hold other duties. Days that the trade headcounts is 20 or less the Subcontractor may designate a worker as the identified Safety Representative. The headcount of trade personnel shall be based on the total for the two projects, Mu2e Conventional Facilities and MC Beamline Enclosure. The Safety Representative may function for both the Mu2e Conventional Facilities, project number 6-10-2 and the MC Beamline Enclosure, project number 6-10-22. The Safety Representative shall have complete the OSHA 30 Hour Construction Training Course.
d. The Subcontractor shall provide an individual, who is an employee of the Subcontractor but independent to the Project's field management, to provide supplementary qualified Safety Representation.
    i) This individual is to participate in the preparatory phase meetings, assist in the safety aspects of planning the work activities and the development of hazard analyses.
    ii) Make site observations during the initial phases of work and perform bi-monthly site walk-though, providing a written report of issues and recommendation to his field superintendent and the FCC.
    iii) The subcontractor's ES&H representative is to assist in any investigations or corrective action planning as needed.
e. Appendix E has additional requirements that shall be included in the Project Specific Environment Safety and Health Plan to the requirements in Exhibit A Section 6. This plan is required after award.

5.3 Construction Schedule

This Project includes the following milestones

1 Milestone 0 – 0 Calendar Days - Notice to Proceed #1 - This milestone marks the point where construction work may begin.

2 Milestone 1 – 37 Calendar Days – All early critical shop drawings submitted.

3 Milestone 2 –80 Calendar Days after NTP – ICW, DWS and Gas utilities rerouted around excavation. The relocation of existing site utilities are complete, testing and placed into service. All restraints for completing the excavation are mitigated and excavation is on-going.

4 Milestone 3 –98 Calendar Days after NTP – Mu2e Conventional Facilities building excavation complete. Excavation and mud slab complete and ready for the structural base mat concrete at the lower level, El 720'-6".

5 Milestone 4 – 112 Calendar Days - Beamline excavation substantially complete

6 Milestone 5 – Mid to late February 2015 – NTP #2 Supplemental agreement issued for remainder of funding less 8%.

7 Milestone 6 – 165 Calendar Days after NTP – Base slab concrete complete. The structural base mat concrete placement at El: 720'-6" and El: 728'-6" is substantially complete. Placement of lower lift walls are in progress.

8 Milestone 7 –200 Calendar Days after NTP – Lower walls complete. Concrete walls and counterforts placement is complete for the lower lift from either the El: 720'-6" or El: 728'-6" slabs. Upper wall lifts are proceeding.

9 Milestone 8 –220 Calendar Days – MC Beamline Enclosure concrete substantially complete including base slabs, walls and roof slabs.

10 Milestone 9 –258 Calendar Days after NTP – Mu2e Structural concrete complete to grade / structure backfilled to grade.

11 Milestone 10 –311 Calendar Days after NTP – Mu2e Structural Steel erected and detailed. Structural steel including columns, beams, girts, framed openings, bracing, crane girder, crane rail and stops installed. Metal roof deck installed; MC Beamline Enclosure earthwork and berms complete, final grading and seeding complete.

12 Milestone 11 – 344 Calendar Days – MC Beamline Enclosure substantially complete / Beneficial Occupancy Issued. Weather tight security wall erected in existing Delivery Ring, Concrete wall at Station 0-05, concrete wall at 0+0 removed.
Partial Beneficial Occupancy of Mu2e enclosure at the El: 726'-6" elevation including that portion of stair # 4 from the El: 726'-6" level to grade including doors, emergency wall pack and battery operated exit signs installed and functioning. Fermilab will occupy the MC Beamline Enclosure (6-10-22) structure and begin to install components. This beneficial occupancy is required for exiting from the enclosure, therefore a 42" clear aisle width shall be maintained at all times to allow access to stair #4 and the exit discharge. The exit discharge to grade and the area outside of the exit on grade shall remain clear. Work is still proceeding in the area; neither the enclosures, enclosure finishes or systems are part of this Beneficial Occupancy.

13 Milestone 12 – approximately 365 days after NTP or October 30, 2015, NTP #3, –Fermi to issue a supplemental agreement for the remaining RFP pricing of the initial contract amount.

14 Milestone 13- 372 Calendar Days - This milestone marks the substantial completion of the MC Beamline Enclosure project including punch list items, clean-up and acceptance of as-built drawings and submittals.

15 Milestone 14 –385 Calendar Days after NTP – Building weather tight. The building's exterior walls are enclosed with siding, roofing is installed, and doors windows and skylights are installed. Some openings for mechanical equipment may have temporary closures installed.

16 Milestone 15 –444 Calendar Days after NTP – Electrical Power systems energized. The 13.8 KV equipment and cable installed, tested and operating. Power loop to MC-1 is complete and operational. Secondary 480 V complete to distribution panels. Power distribution and lighting is substantially complete. Power to crane disconnects complete.

17 Milestone 16 - 458 Calendar Days after NTP – 30 ton overhead cranes installed and load tested.

18 Milestone 17 –479 Calendar Days after NTP – Substantially complete / Beneficial Occupancy Issued for entire structure. All work is substantially completed, tested and operational; ready for the development of punch list. All required testing of piping, mechanical and electrical systems are complete, conform to the specifications and operational. Testing report have been submitted. Subcontractor has identified and mitigated deficiencies, ready for Fermilab to developed punch list. Life safety provisions install, tested and operational.

19 Milestone 18–501 Calendar Days after NTP – Project Complete / Final Acceptance Issued. This milestone marks the completion of the Project including punch list items, clean-up and acceptance of as-built drawings, operations manuals and submittals. Subcontractor can invoice for retention.

In addition to the schedule requirements in the Exhibit A Section 5.3 “Construction Schedule” the Subcontractor shall provide the following:

a. A cost loaded construction schedule shall be submitted in both hard copy and electronic formats in a file directly readable into Primavera P6 Professional R.8.2.
    i. The schedule shall be organized using **the work scope associated with each NTP as the top level of the WBS and organized by the 16 CSI divisions as the next level of the WBS**. Costs are to be applied to the activities and rolled up to the WBS level.
    ii. Changes to the baseline schedule shall only be made as a result of a supplemental agreement.
    iii. Fermilab will report monthly on the subcontractor’s progress comparing the earned value to planned value based the Subcontractor’s baseline schedule. Submitted with the baseline schedule, and modified after supplemental

agreements, provide in tabular form the planned earned value to the last workday of each month.

iv. The schedule shall include the subcontract milestones. The NTP MS-0, Bea and Project Complete MS-20 milestones shall be the only two project constraints. Milestones 1 through 10 shall be driven by the logical relationships between activities.

v. Activity durations should be elaborated so that the activity duration is restricted to between five (5) and twenty (20) working days.

vi. The schedule shall include activities for the initial submittal for all major work elements.

vii. An updated submittal of the construction schedule in both print and electronic formats shall be submitted after each supplemental agreement has been issued and signed. This submittal is required at least five (5) work days prior to an update for progress payment. This revised schedule becomes the baseline schedule.

viii. Progress payment request shall include, in print format, activity actual start and finish dates and activity percent complete.

b. The Subcontractor shall submit with all progress payment requests a Schedule Performance Index (SPI), computed by dividing the Budged Cost of work planned by the actual cost of work performed. This shall be calculated and submitted separately for each scope of work funded under a distinct NTP.

i. A recovery schedule is required within ten (10) work days of a progress payment when the SPI is less than .95 at the CSI division WBS level.

ii. A written explanation is required within ten (10) work days of a progress payment when the SPI is less than .95 at the CSI division WBS level that explains the causes for the schedule variance.

c. In addition to the requirements in Exhibit A Section 5.4 (Weekly Progress Meetings) the subcontractor shall provide a two week look ahead schedule indicating the following:

i. Scheduled work activities to be started, in progress or completed in the succeeding two weeks.

ii. Status of material submittals.

iii. Status of RFI's.

iv. Activities requiring the services or materials provided by Fermilab including permits, survey quality assurance checks, delivery or pick-up of Fermilab supplied materials."

5.7 Submittals

Submittals are defined as shop drawings, material samples, operations and maintenance manuals for all materials and assemblies used on the Project which are normally required in the construction industry. Also included in the submittals are those documents required by this Exhibit A or any Exhibit B, Technical Specification. Not included as a submittal are any documents required by Fermilab Procurement. The following information and requirements pertain to submittals for this Project:

1. Shop drawings shall conform to the requirements of Section 5.5 through 5.8 of FL-3, **Fermilab Construction Subcontract Terms and Conditions;**
2. Submittals shall include a cover sheet that includes (at a minimum) the following information:
   a. Subcontractor name, address, contact information;

b. Subcontract purchase order number;
c. FESS/E Project name and number;
d. Specification and/or drawing number that defines the product;
e. Confirmation that the submittal complies with 5.5 of FL-3, Fermilab Construction Subcontract Terms and Conditions.

3. The Subcontractor shall submit one (1) one electronic copy of submittals;
4. The Subcontractor shall supply two (2) printed copies and one (1) electronic copy of all operation and maintenance manuals for equipment furnished by the Subcontractor or his Sub-tier contractor prior to final acceptance of the Project by Fermilab.
5. Electronic submittals shall be in the "portable document format" (PDF) as developed by Adobe, Incorporated;
6. Fermilab will review submittals and return one (1) electronic copy of all submittals within 15 (fifteen) working days with one (1) of the following actions:
   a. "No exception Taken" response on the Subcontractor's shop drawings submittal and "**NET**" as shown on the Material Submittal for Review form indicates the Subcontractor may proceed with procurement, fabrication, manufacture and installation of the material and/or product.
   b. "Revise & Resubmit – Fabrication May Proceed" on the Subcontractor's shop drawing submittal and "**R/R**" as shown on the Material Submittal for Review form indicates the Subcontractor may proceed with procurement, fabrication, and manufacture of the material and/or product assuming the noted items on the submittal are incorporated into the final design and/or product. The Subcontractor will revise the shop drawings and resubmit them to Fermilab for approval, but will not be able to erect and/or install any material until he has received either the "No Exception Taken (NET)" or the "Make Corrections and Proceed (MCP)" action by Fermilab.
   c. "Make Corrections & Proceed" response on the Subcontractor's shop drawing submittal and "**MCP**" as shown on the "Material Submittal for Review" form indicates the Subcontractor may proceed with procurement, fabrication, manufacture and installation of the material and/or product assuming the noted items on the submittal are incorporated into the final design and/or product.
   d. With the "Rejected" response on the Subcontractor's shop drawing submittal and "**R**" as shown on the Material Submittal for Review form, the reasons for the disapproval will be stated on the shop drawing submittal. The Subcontractor will revise the shop drawing submittal to conform to the drawings and specifications and resubmit them to Fermilab for approval. No procurement, fabrication, manufacture or installation shall be performed by the Subcontractor until one of the above actions listed under Section 6(a), 6(b), or 6(c).
   e. "For Information Only" response on the Subcontractor's shop drawing submittal and "**FIO**" on the Material Submittal for Review form acknowledges receipt of such items as test results, professional engineering calculations, welding certificates and inspection reports.
7. Submittals which are valid for both the Mu2e Conventional Facilities (6-10-2) and the MC Beamline Enclosure (6-10-22) need only to be submitted once as a common submittal. The cover sheet for submittals shall be clearly be noted if the submission is for both projects or only applies to one of the projects."

5.11 Project Bulletin Board

The Subcontractor shall provide a Project Bulletin Board that complies with Section 32 of FL-3, Fermilab Construction Subcontract Terms and Conditions.

5.13 Quality Requirements

Project Quality Control Plan

The Subcontractor shall submit a Project Quality Control (PQC) Plan with the proposal which identifies personnel, procedures, control, instructions, test, records, and forms to be used specific to this Project at

Fermilab. The PQC Plan shall include, as a minimum, the following information to cover all construction operations, both onsite and offsite, including work by sub-tier contractors, fabricators, suppliers, and purchasing agents:

1. The name, qualifications, duties, responsibilities, and authorities of each person assigned a Quality Control function, including the identity of the Project Quality Control Manager.
2. As a minimum, the Project Quality Control Manager shall be responsible for the following:
   a. Interface with Fermilab Construction Coordinator on all quality matters;
   b. Maintain all quality related records;
   c. Review, submittal and tracking of submittals;
   d. Coordinate and participate in all preparatory, initial and follow-up meetings;
   e. Attend weekly construction meetings;
   f. Assure all required testing is performed;
   g. Develop and maintain deficiency list;
   h. Prepare and submit daily quality control reports;
   i. Participate in beneficial occupancy, punchlist and final inspections;
3. The Subcontractor shall provide as part of the Quality Control organization, specialized personnel to assist the Quality Control Manager for the discipline(s) specified below. These individuals may be employees of the Subcontractor or Sub-tier contractor; will be responsible to the Quality Control Manager; must be physically present at the construction site during work on their areas of responsibility; must have the necessary education and/or experience in accordance with the experience matrix listed herein. These individuals may perform other duties but must be allowed sufficient time to perform their assigned Quality Control duties.
4. Control, verification, and acceptance testing procedures for each specific test required by the Subcontractor;
5. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.
6. A list of the definable features of work. A definable feature of work is a task that is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment.
7. The PQC Plan shall incorporate any changes in scope of work, due to directed field changes or supplemental agreements, as these changes occur.
8. Fermilab reserves the right to require the Subcontractor to make changes in his PQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified (see Section 34.3 of FL-3, Fermilab Construction Subcontract Terms and Conditions).

Implementation

The Subcontractor shall ensure that the construction, including work by sub-tier contractors and suppliers, complies with the requirements of the Subcontract. At least three (3) phases of control shall be conducted by the Quality Control Manager for each definable feature of work as follows:

1. Preparatory Phase: This phase shall be performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:
   a. The Fermilab Construction Coordinator shall be notified at least 24 hours in advance of beginning the preparatory control phase;
   b. This phase shall include a meeting conducted by the Quality Control Manager and attended by the superintendent, other Quality Control personnel (as applicable), and the foreman responsible for the definable feature;
   c. The Subcontractor shall document any discussions during this phase;
   d. The Subcontractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet Subcontract specifications;

e. A review of the Subcontract documents applicable to this feature of work, including appropriate clauses in FL-3, Fermilab Construction Subcontract Terms and Conditions; e.g., sections 2 and 9;
f. Review of provisions that have been made to provide required control inspection and testing;
g. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the Subcontract;
h. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored;
i. A review of the appropriate activity hazard analysis to assure safety requirements is identified;
j. Discussion of procedures for controlling quality of the work including repetitive deficiencies;
k. Verification of construction tolerances and workmanship standards for that feature of work;

2. Initial Phase: This phase shall be accomplished at the beginning of a definable feature of work. The following shall be accomplished:
   a. The Fermilab Construction Coordinator shall be notified at least 24 hours in advance of beginning the initial phase.
   b. The Subcontractor shall document any discussion during this phase.
   c. The work completed in this phase sets the standard for future work and should be identified for future reference.
   d. A check of work to ensure that it is in full compliance with Subcontract requirements. Review minutes of the preparatory meeting.
   e. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards.
   f. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity hazard analysis with each employee, particularly new workers.

3. Follow-up Phase: Daily checks shall be performed by the Quality Control Manager to assure quality control activities, including quality control testing, are providing continued compliance with Subcontract requirements, until completion of the particular feature of work. The Subcontractor shall document these checks in the Daily Quality Control Report.

Testing

The Subcontractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to Subcontract requirements. The following describes the minimum requirements:

1. Results of all tests taken, both passing and failing tests, shall be recorded on the Quality Control report for the date taken;
2. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given;
3. An information copy of tests performed by an offsite or commercial test facility shall be provided in the form of submittal;
4. The Daily Quality Report recording testing results shall be resubmitted.

Documentation

The following describes the requirements for the quality control documentation required for this Project:

1. The Subcontractor shall maintain current records providing factual evidence that required Quality Control activities and/or tests have been performed;
2. The quality control records shall be submitted weekly to the Fermilab Construction Coordinator on a weekly basis;
3. The quality control records shall include the work of sub-tier contractors and suppliers.

6.3 Environment Safety and Health Plan

The Environment Safety and Health Plan shall be submitted with the proposal.

6.10 Job Site ES&H Meetings

Monthly ES&H meetings shall be conducted by the Subcontractor's Field Superintendent at the job site. The purpose of these meetings is to assist in highlighting and reinforcing the Subcontractor's ES&H Plan. It is expected that these meetings will typically last one (1) hour.

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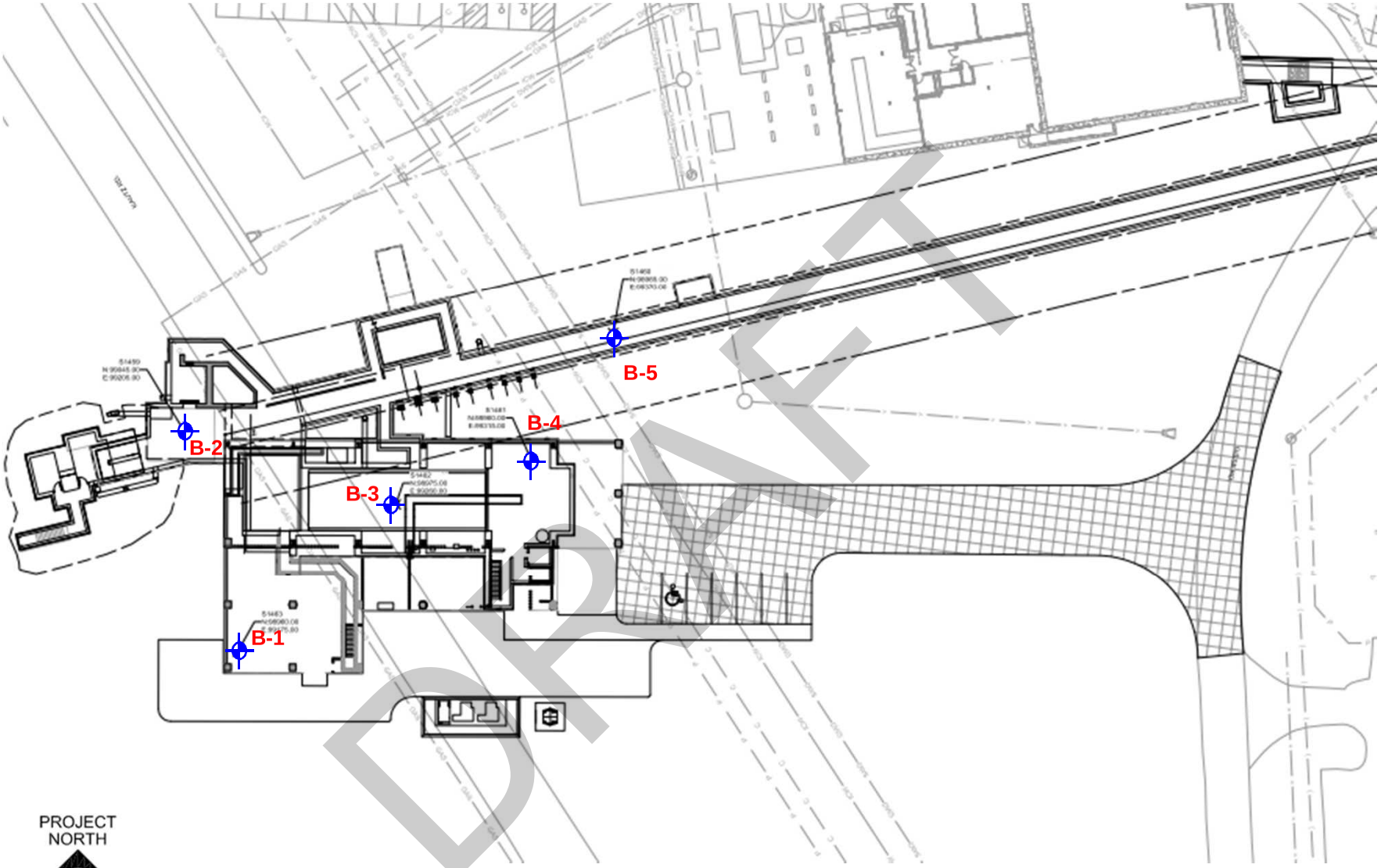
Appendix C; Soil Boring Logs

Field Exploration Description

The borings were drilled at the approximate locations indicated on the attached Boring Location Diagram (Exhibit A-2). A Fermilab representative marked the boring locations in the field prior to our subsurface exploration. The surface elevations indicated on the logs were estimated from the topographic plan provided by the client. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a track-mounted, rotary drill rig using hollow stem augers to advance the boreholes. Soil samples were obtained using split-barrel sampling procedures, in which a standard 2-inch (outside diameter) split-barrel sampling spoon is driven into the ground with a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. These values, also referred to as SPT N-values, are provided on the boring logs at the depths of occurrence. The samples were sealed and transported to the laboratory for testing and classification.

The drill crew prepared a field log of each boring. These logs included visual classifications of the materials encountered during drilling and the driller's interpretation of the subsurface conditions between samples. The boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.



PROJECT NORTH

W E S

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: AF	Project No. 11135045
Drawn by: AF	Scale: N.T.S.
Checked by: KCB	File Name: 11135045 BLD
Approved by: KCB	Date: May 2013

Terracon
Consulting Engineers & Scientists
135 Ambassador Drive Naperville, Illinois 60540
P [630] 717 4263 F [630] 357 9489

BORING LOCATION DIAGRAM

FERMILAB MU2E BUILDING
BATAVIA, ILLINOIS

Exhibit

A-2

BORING LOG NO. 1

PROJECT: Fermilab Mu2e Building

CLIENT: Middough, Inc.
Oak Brook, IL

SITE: Fermi National Accelerator Lab
Batavia, IL

LOCATION See Exhibit A-2

Approximate Surface Elev: 755 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
0.5	754.5+/-	**TOPSOIL**, approximately 6"
		FILL - LEAN CLAY, trace sand and gravel, olive-brown and dark brown
8.0	747+/-	**LEAN CLAY**, trace sand and gravel, olive gray, stiff
14.0	741+/-	**SANDY LEAN CLAY (CL)**, trace gravel, yellowish-brown, very stiff
18.0	737+/-	**SILTY SAND (SM)**, gray and yellowish-brown, medium dense
24.0	731+/-	**LEAN CLAY (CL)**, trace gravel, gray, stiff to very stiff
40.0	715+/-	***Boring Terminated at 40 Feet***

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HP (psf)	WATER CONTENT (%)
		10	5-5-5 N=10		23
5		16	4-5-7 N=12		33
		12	9-9-10 N=19		29
10		16	5-5-6 N=11	2000	26
15		18	6-8-8 N=16		19
20		17	6-7-9 N=16		18
25		17	5-6-7 N=13	5000	14
30		17	10-12-14 N=26	5000	16
35		16	11-11-12 N=23	6000	14
40		14	10-11-11 N=22	6000	17

WATER LEVEL OBSERVATIONS

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

See Exhibit A-1 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

14 ft, While Drilling

14 ft, After Boring

Terracon
135 Ambassador Drive
Naperville, Illinois

Boring Started: 5/1/2013 | Boring Completed: 5/1/2013

Drill Rig: D-90 | Driller: JA

Project No.: 11135045 | Exhibit: A-3

BORING LOG NO. 2

PROJECT: Fermilab Mu2e Building

CLIENT: Middough, Inc.
Oak Brook, IL

SITE: Fermi National Accelerator Lab
Batavia, IL

LOCATION See Exhibit A-2

Approximate Surface Elev: 745 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HP (psf)	WATER CONTENT (%)
0.5	744.5+/-	**TOPSOIL**, approximately 6"							
		FILL - LEAN CLAY, trace sand and gravel, dark brown to olive-brown			X	8	7-7-7 N=14		27
					X	10	4-4-5 N=9		29
6.0	739+/-		5		X	16	6-6-8 N=14	7000	26
		LEAN CLAY (CL), trace sand and gravel, stiff to very stiff							
9.0	736+/-				X	14	7-8-8 N=16	8000	18
		SILT (ML), yellowish-brown, medium dense	10						
14.0	731+/-			▽	X	16	6-6-7 N=13	5000	15
		LEAN CLAY (CL), trace sand and gravel, gray, stiff to hard	15						
					X	14	12-12-15 N=27	6000	16
			20						
					X	5	50/5" N=50/5"	6000	15
			25						
					X	12	12-16-18 N=34	+9000	15
			30						
					X	8	16-18-22 N=40	+9000	8
			35						
40.0	705+/-				X	10	10-10-19 N=29	+9000	14
		Boring Terminated at 40 Feet	40						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

See Exhibit A-1 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *14 ft, While Drilling*

▽ *14 ft, After Boring*

Terracon
135 Ambassador Drive
Naperville, Illinois

Boring Started: 5/1/2013 | Boring Completed: 5/1/2013

Drill Rig: D-90 | Driller: JA

Project No.: 11135045 | Exhibit: A-4

BORING LOG NO. 3

PROJECT: Fermilab Mu2e Building

CLIENT: Middough, Inc.
Oak Brook, IL

SITE: Fermi National Accelerator Lab
Batavia, IL

LOCATION See Exhibit A-2

Approximate Surface Elev: 745 (Ft.) +/-

DEPTH	ELEVATION (Ft.)		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HP (psf)	WATER CONTENT (%)
0.5	744.5+/-	**TOPSOIL**, approximately 6"							
		FILL - LEAN CLAY, trace sand and gravel, olive-brown and gray			X	10	5-4-6 N=10		24
					X	10	4-5-5 N=10		22
6.0	739+/-		5		X	14	5-4-5 N=9		24
		SANDY LEAN CLAY (CL), trace gravel, olive gray, stiff							
9.0	736+/-			▽	X	18	4-4-4 N=8		14
		SAND (SP), trace gravel, olive gray, loose	10	▽					
14.0	731+/-				X	12	9-9-10 N=19		15
		SILT (ML), trace sand and gravel, olive gray, medium dense	15						
18.0	727+/-								
		LEAN CLAY (CL), trace gravel and silt, gray, very stiff to hard			X	16	7-9-11 N=20	9000	16
			20						
					X	17	7-10-12 N=22	9000	13
			25						
29.0	716+/-				X	10	20-25-28 N=53	+9000	14
		GRAVELLY LEAN CLAY (CL), gray, hard	30						
					X	0	23-25-30 N=55		
			35						
39.0	706+/-								
40.0	705+/-	**LEAN CLAY (CL)**, trace gravel, gray, hard			X	17	14-12-13 N=25	+9000	19
			40						
		Boring Terminated at 40 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

See Exhibit A-1 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *9 ft, While Drilling*

▽ *10 ft, After Boring*

Terracon
135 Ambassador Drive
Naperville, Illinois

Boring Started: 5/2/2013 | Boring Completed: 5/2/2013

Drill Rig: D-90 | Driller: JA

Project No.: 11135045 | Exhibit: A-5

BORING LOG NO. 4

PROJECT: Fermilab Mu2e Building

CLIENT: Middough, Inc.
Oak Brook, IL

SITE: Fermi National Accelerator Lab
Batavia, IL

LOCATION See Exhibit A-2

Approximate Surface Elev: 745 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
0.4	744.5+/-	**TOPSOIL**, approximately 4"
		FILL - SANDY LEAN CLAY, trace gravel and organics, dark brown
6.0	739+/-	
		FILL - LEAN CLAY, trace sand and gravel, olive-brown and dark gray
9.0	736+/-	
		SILT (ML), gray, medium dense
14.0	731+/-	
		LEAN CLAY (CL), trace sand and gravel, gray, very stiff
40.0	705+/-	
		Boring Terminated at 40 Feet

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HP (psf)	WATER CONTENT (%)
0					
		12	5-6-6 N=12		21
5		16	9-8-10 N=18		14
		14	7-10-10 N=20		22
		16	6-6-7 N=13		19
10					
		16	12-12-12 N=24	6000	16
15					
		16	12-12-13 N=25	7000	16
20					
		17	9-9-10 N=19	6000	17
25					
		16	12-10-10 N=20	8000	15
30					
		18	9-9-10 N=19	8000	15
35					
		17	10-9-10 N=19	8000	13
40					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

See Exhibit A-1 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *14 ft, While Drilling*

None, After Boring

Terracon
135 Ambassador Drive
Naperville, Illinois

Boring Started: 5/2/2013 | Boring Completed: 5/2/2013

Drill Rig: D-90 | Driller: JA

Project No.: 11135045 | Exhibit: A-6

BORING LOG NO. 5

PROJECT: Fermilab Mu2e Building

CLIENT: Middough, Inc.
Oak Brook, IL

SITE: Fermi National Accelerator Lab
Batavia, IL

LOCATION See Exhibit A-2

Approximate Surface Elev: 750 (Ft.) +/-

DEPTH	ELEVATION (Ft.)		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HP (psf)	WATER CONTENT (%)
		FILL - LEAN CLAY, trace sand and gravel, olive-brown and gray							
					X	8	2-2-2 N=4		26
					X	5	2-3-3 N=6		25
6.0	744+/-		5		X	14	2-4-7 N=11	2000	21
		SILTY CLAY (CL-ML), trace gravel, olive gray, stiff		▽					
9.0	741+/-				X	10	8-10-10 N=20		18
		SAND (SP), trace gravel, yellowish-brown, medium dense	10						
14.0	736+/-				X	17	6-6-8 N=14	5000	17
		LEAN CLAY (CL), trace gravel, gray, stiff to very stiff	15						
					X	0	10-5-5 N=10		
			20						
					X	16	9-10-10 N=20	8000	17
29.0	721+/-		25						
		GRAVELLY LEAN CLAY (CL), gray, hard			X	5	28-23-20 N=43	+9000	9
			30						
					X	0	30-34-40 N=74		
38.7	711.5+/-		35						
		Boring Terminated at 38.65 Feet				0	50/2" N=50/2"		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

See Exhibit A-1 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *9 ft, While Drilling*

None, After Boring

Terracon
135 Ambassador Drive
Naperville, Illinois

Boring Started: 5/2/2013 | Boring Completed: 5/2/2013

Drill Rig: D-90 | Driller: JA

Project No.: 11135045 | Exhibit: A-7

APPENDIX B

LABORATORY TESTING

Laboratory Testing

The soil samples obtained from the borings were tested in the laboratory to measure their natural water contents. A pocket penetrometer was used to help estimate the approximate unconfined compressive strength of selected cohesive samples. The test results are provided on the boring logs in Appendix A.

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the limited laboratory testing described above. The soil descriptions presented on the boring logs for native soils are in accordance with the enclosed General Notes (Exhibit C-1) and Unified Soil Classification System (USCS). The estimated USCS group symbols for native soils are shown on the boring logs, and a brief description of the USCS (Exhibit C-2) is included in this report.

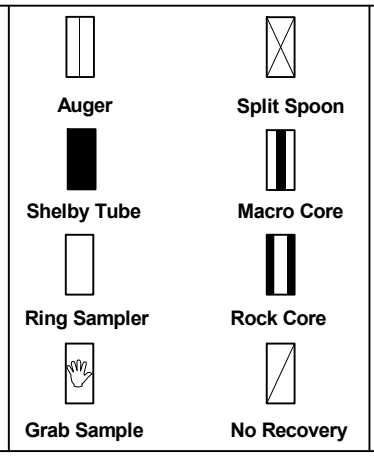
APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

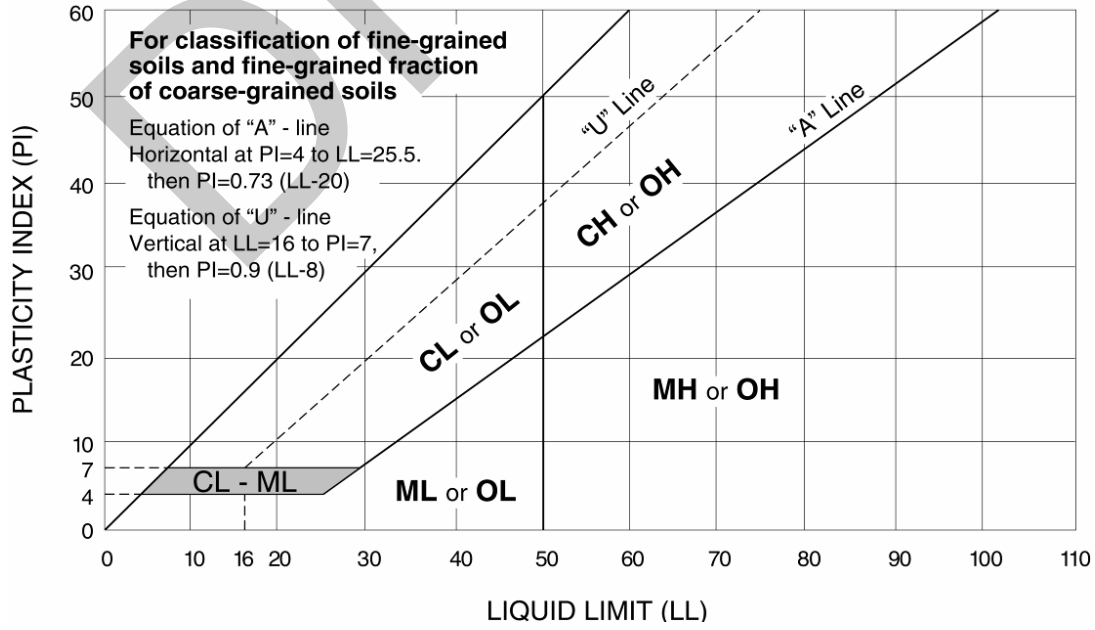
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit C-2

Appendix D; Soil and water Pollution Protection Plan (SWPPP)

NPDES PERMIT NO. ILR 10
STORM WATER POLLUTION PREVENTION PLAN
FOR THE
MUON CAMPUS PROJECT

I. PROJECT OVERVIEW

1.0 SITE DESCRIPTION

The Muon Campus project has been divided into two (2) phases. Phase 1 of the project will construct a new general purpose, 13,500 square foot building. Phase 2 of the project will construct roughly 33,000 square feet of above and below ground building space and an underground beamline enclosure.

Utilities for the buildings will be tapped from nearby feeders and piping in existing utility corridors, including; electrical, communications, natural gas, industrial cooling water, sanitary sewer, domestic water and chilled water. The proposed site has been examined and is not in any wetlands, defined floodplain, or other protected area. Soil erosion and sedimentation control measures will be implemented per the design specifications and drawings.

Site specific construction activities to the Phase 2 work involving the construction of the Mu2e Conventional Facilities and Underground MC Beamline Enclosure are as follows:

1.1 Construction Sequence

Muon Campus soil disturbing activities began in January 2013 and are planned to be completed by September 2017. Mu2e Conventional Facilities and MC Beamline Enclosure construction is planned to begin July 7, 2014 and completed by December 22, 2015

Clearing, Grubbing, Installation of Soil Erosion and Sedimentation Control measures.

July 7, 2014 to August 22, 2014

Stripping Topsoil and Excavation for Building Foundations, MC Beamline Enclosure, Site Prep and Utility Installations.

July 7, 2014 to November 14, 2014

MC Beamline Enclosure Structural Concrete Complete to Grade.

August 15, 2014 to January 20, 2015

Installation of Building/Beamline Foundations and Walls, Structural Concrete Complete to Grade and Building/Beamline Structures Backfilled to Grade.

October 1, 2014 to April 23, 2015

MC Beamline Enclosure Berm Construction and Stabilization.

April 1, 2015 to June 30, 2015

Project Complete, Final Acceptance MC Beamline Enclosure

June 15, 2015 to June 30, 2015

Above Grade Building Construction and Final Site Grading and Stabilization, Building Complete to Beneficial Occupancy

April 24, 2015 to November 30, 2015

Project Complete, Final Acceptance Mu2e Conventional Facilities

February 1, 2016 to February 22, 2016

1.2 Site Area

Soil disturbing activities for the Muon Campus project is estimated to be 10.1 acres. Phase 2 construction is estimated at 6.3 acres of the 10.1 acre site.

1.3 Runoff Estimates

The entire Fermilab site is 6,800 acres. The nominal increase in impervious area created with this project will not result in any increased runoff from the site.

The receiving water for this project is Indian Creek.

1.4 Site Maps

Refer to Sheet SESCP-1 for Erosion Control Plans and SESCP-2 for Erosion Control Details. (These sheets are part of this document)

2.0 STORM WATER CONTROLS

Stabilization and Structural practices to be incorporated will be in accordance to the Illinois Urban Manual and as shown in the attached Erosion Control Plans and Details.

2.1 Erosion and Sediment Controls

Perimeter controls will initially be installed around the MC Beamline Enclosure portion of the construction project and extended to include the Mu2e Conventional Facility construction afterwards. Mu2e Conventional Facility perimeter controls will be installed as clearing and grubbing operations are completed.

Structural practices:

2.2 Stabilization Practices

Temporary and permanent seeding within the construction areas will be employed. Stabilization of disturbed areas will be initiated within 1 working day of temporary or permanent cessation of earth disturbing activities and completed as soon as possible but within 14 days from the initiation of stabilizing work activities in the area. Permanently seeded areas will be protected with the use of straw mulching, vegetative buffer filter strips, and erosion control blankets on side slopes.

Dates when major grading activities occur, or when major activities temporarily cease or portions of permanent stabilization commence shall be recorded in the weekly inspection log sheets.

Where initiation of stabilization measures are precluded by snow cover, stabilization measures shall be initiated as soon as practical.

2.3 Structural Practices

Confinement of sediment within the construction site area will be controlled by silt fencing, drainage swales, ditch checks, storm drain inlet protection and stabilized construction entrances.
A sediment basin will be constructed to handle site area dewatering needs for both the Mu2e Conventional Facilities foundation excavation and MC Beamline Enclosure construction.

All existing storm drainage conveyances will be maintained during construction and restored to original conditions, if needed, at the end of construction.

The overall storm water management plan throughout the duration of the project will be to minimize passage of pollutants into the drainage way leading to Indian Creek. No process water wastes will be discharged into Indian Creek.

The functioning drainage characteristics during the sequence of construction will be of equal or improved quality when compared to the original site conditions.

2.4 Pollution Prevention

Building Materials, construction debris, landscape materials and fertilizers shall be kept protected from precipitation and storm water flows by protective storage and covering and proper disposal of materials in construction site dumpsters.

Spill Prevention is covered in Fermi National Accelerator Laboratory's SPCC Plan and FESHM Chapter 8030 Chemical Releases, Spill Prevention and Response

2.5 Other Controls

No solid materials shall be discharged to waters of the State.

All phases of construction will have designated Concrete Truck Washout areas to protect any discharges from entering drainage ways.

2.6 Best Management Practices for Post Construction

Post Construction management practices to include weekly monitoring of installed control devices, erosion blankets, straw wattles/ ditch checks, ditches/swales, rip-rap and general seeded areas to ensure continued control of disturbed areas until satisfactory stabilization has been attained. Any issues with current control devices will be addressed and repaired as soon as reasonably possible.

2.5 Approved State or Local Plans

The management practices and controls as defined in this plan shall be in accordance to Illinois Urban Manual, latest edition. No other local documents or plans apply to work activities on this project.

3.0 MAINTENANCE

All erosion and sediment control measures shall be maintained in functional condition through completion of the project by the *Subcontractor and as follows:*

1. Maintain site areas
2. Maintain silt fencing and vegetative boundaries
3. Maintain sediment basins
4. Install and maintain temporary/permanent seeding
5. Maintenance of stockpile areas
6. Maintain concrete truck washout areas and disposal of material

Typical Maintenance Procedures shall be as follows:

1. Removal and disposal of accumulated sediments to ensure functionality
2. Replacement and or repair of devices damaged from storms or construction activities
3. Dust control procedures on site roads and construction areas will be maintained through periodic watering as required and removal of loose material on all paved areas at the end of each work day.

4.0 INSPECTIONS

Site inspections will be conducted by qualified Fermi personnel and *Subcontractor personnel* in accordance to the permit requirements and at a minimum of at least once every seven calendar days or within 24 hours of any rainfall or equivalent snow event of a ½ inch or greater.

The Subcontractor shall call the automated Fermi Site Weather Station at (630) 840-2172 for continuous 24 hour precipitation totals in determining inspection response to rainfall and snow events.

The Subcontractor shall also maintain a field log of inspection reports and submit a copy of the log to the Fermi Construction Coordinator at the end of each week through completion of the project. Weekly inspections may be reduced to once per month when construction activities have ceased due to frozen conditions. Weekly inspections will recommence once construction activities restart or within 24 hours of any rainfall or equivalent snow event of a ½ inch or greater.

5.0 NON-STORM WATER DISCHARGES

Water and concrete generated in the designated Concrete Truck Washout areas will be removed from the site and disposed of as unsuitable material once stabilized.

II. ADDITIONAL REQUIREMENTS FOR STORM WATER DISCHARGE FROM INDUSTRIAL ACTIVITIES OTHER THAN CONSTRUCTION

No other activities expected

III. CONTRACTOR AND SUBCONTRACTOR RESPONSIBILITIES

The overall contractor is Fermi Research Alliance LLC (FRA). For the overall scope of the project, the Subcontractor that will be responsible for the erosion and sediment control measures for each particular job will be identified in this Plan. An authorized representative from the subcontracting firms will sign this document certifying compliance with the General Permit conditions.

IV. SEDIMENTATION AND EROSION CONTROL PLANS follow the certification page and specifications are located in technical specification, Division 2, section 02370 entitled “Erosion Control”.

OWNER CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Department of Energy
Batavia Area Office
DOE Fermi Group Manager
P.O. Box 2000
Batavia, IL 60510
(630) 840-3281

_____
Michael J. Weis

_____
Date

CONTRACTOR CERTIFICATION

"I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR 10) that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification."

Fermi Research Alliance LLC
Wilson and Kirk Rds.
P.O. Box 500
MS 105
Batavia, IL 60510
(630) 840-3211

_____
Nigel Lockyer
Fermilab Director

_____
Date

SUBCONTRACTOR CERTIFICATION

"I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR 10) that authorizes the storm water discharges associated with the industrial activity from the construction site identified as part of this certification."

Firm:

_____ _____
Owner/Representative

_____

_____ _____
Date

Phone_____

SUBCONTRACTOR CERTIFICATION

"I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR 10) that authorizes the storm water discharges associated with the industrial activity from the construction site identified as part of this certification."

Firm:

_____ _____
Owner/Representative

_____

_____ _____
Date

Phone_____

SUBCONTRACTOR CERTIFICATION
"I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR 10) that authorizes the storm water discharges associated with the industrial activity from the construction site identified as part of this certification."

Firm:

_____ _____
Owner/Representative

_____

_____ _____
Date

Phone_____

SUBCONTRACTOR CERTIFICATION
"I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR 10) that authorizes the storm water discharges associated with the industrial activity from the construction site identified as part of this certification."

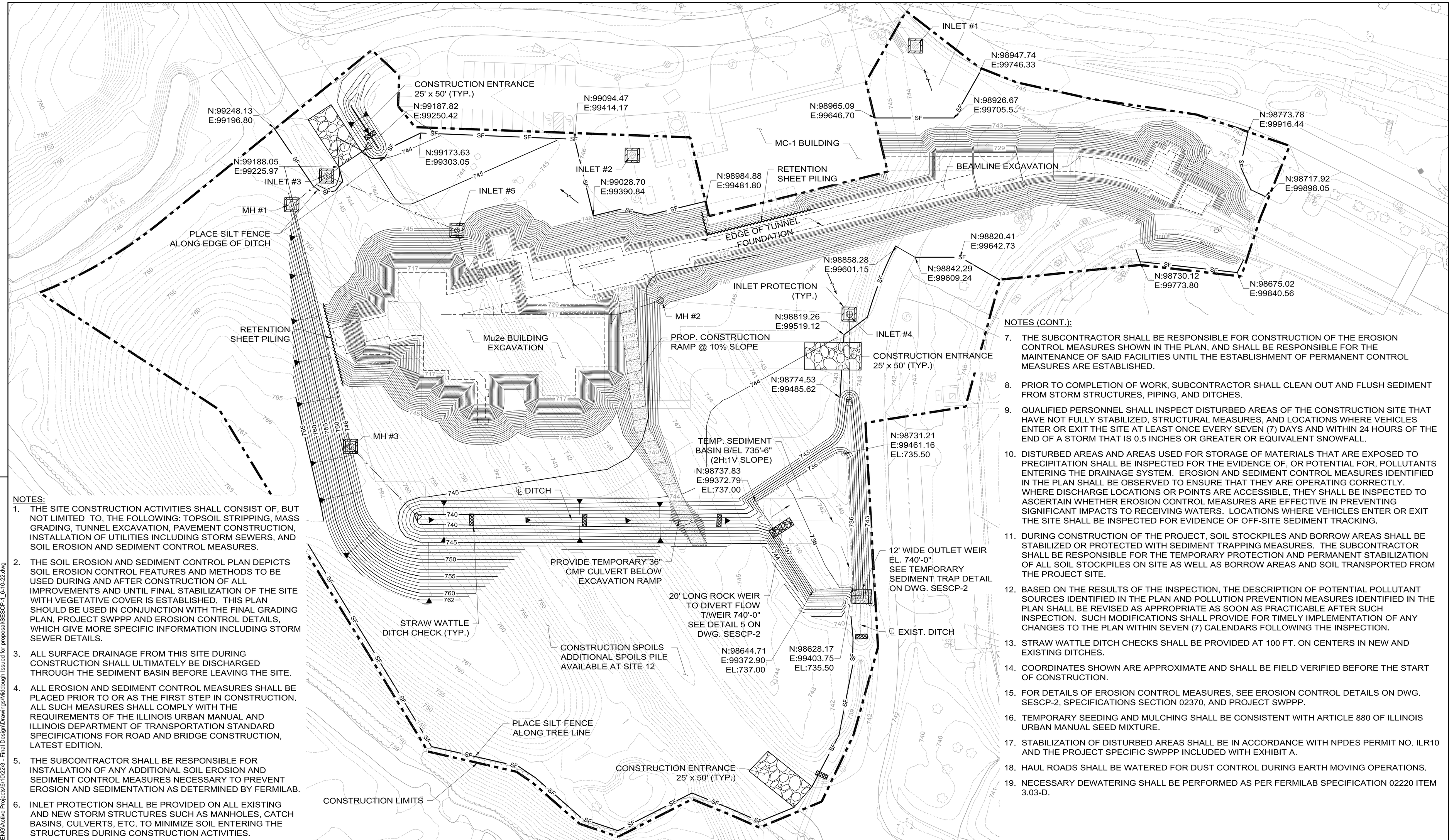
Firm:

_____ _____
Owner/Representative

_____

_____ _____
Date

Phone_____



NOTES:

1. THE SITE CONSTRUCTION ACTIVITIES SHALL CONSIST OF, BUT NOT LIMITED TO, THE FOLLOWING: TOPSOIL STRIPPING, MASS GRADING, TUNNEL EXCAVATION, PAVEMENT CONSTRUCTION, INSTALLATION OF UTILITIES INCLUDING STORM SEWERS, AND SOIL EROSION AND SEDIMENT CONTROL MEASURES.
2. THE SOIL EROSION AND SEDIMENT CONTROL PLAN DEPICTS SOIL EROSION CONTROL FEATURES AND METHODS TO BE USED DURING AND AFTER CONSTRUCTION OF ALL IMPROVEMENTS AND UNTIL FINAL STABILIZATION OF THE SITE WITH VEGETATIVE COVER IS ESTABLISHED. THIS PLAN SHOULD BE USED IN CONJUNCTION WITH THE FINAL GRADING PLAN, PROJECT SWPPP AND EROSION CONTROL DETAILS, WHICH GIVE MORE SPECIFIC INFORMATION INCLUDING STORM SEWER DETAILS.
3. ALL SURFACE DRAINAGE FROM THIS SITE DURING CONSTRUCTION SHALL ULTIMATELY BE DISCHARGED THROUGH THE SEDIMENT BASIN BEFORE LEAVING THE SITE.
4. ALL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE PLACED PRIOR TO OR AS THE FIRST STEP IN CONSTRUCTION. ALL SUCH MEASURES SHALL COMPLY WITH THE REQUIREMENTS OF THE ILLINOIS URBAN MANUAL AND ILLINOIS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, LATEST EDITION.
5. THE SUBCONTRACTOR SHALL BE RESPONSIBLE FOR INSTALLATION OF ANY ADDITIONAL SOIL EROSION AND SEDIMENT CONTROL MEASURES NECESSARY TO PREVENT EROSION AND SEDIMENTATION AS DETERMINED BY FERMILAB.
6. INLET PROTECTION SHALL BE PROVIDED ON ALL EXISTING AND NEW STORM STRUCTURES SUCH AS MANHOLES, CATCH BASINS, CULVERTS, ETC. TO MINIMIZE SOIL ENTERING THE STRUCTURES DURING CONSTRUCTION ACTIVITIES.

NOTES (CONT.):

7. THE SUBCONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTION OF THE EROSION CONTROL MEASURES SHOWN IN THE PLAN, AND SHALL BE RESPONSIBLE FOR THE MAINTENANCE OF SAID FACILITIES UNTIL THE ESTABLISHMENT OF PERMANENT CONTROL MEASURES ARE ESTABLISHED.
8. PRIOR TO COMPLETION OF WORK, SUBCONTRACTOR SHALL CLEAN OUT AND FLUSH SEDIMENT FROM STORM STRUCTURES, PIPING, AND DITCHES.
9. QUALIFIED PERSONNEL SHALL INSPECT DISTURBED AREAS OF THE CONSTRUCTION SITE THAT HAVE NOT FULLY STABILIZED, STRUCTURAL MEASURES, AND LOCATIONS WHERE VEHICLES ENTER OR EXIT THE SITE AT LEAST ONCE EVERY SEVEN (7) DAYS AND WITHIN 24 HOURS OF THE END OF A STORM THAT IS 0.5 INCHES OR GREATER OR EQUIVALENT SNOWFALL.
10. DISTURBED AREAS AND AREAS USED FOR STORAGE OF MATERIALS THAT ARE EXPOSED TO PRECIPITATION SHALL BE INSPECTED FOR THE EVIDENCE OF, OR POTENTIAL FOR, POLLUTANTS ENTERING THE DRAINAGE SYSTEM. EROSION AND SEDIMENT CONTROL MEASURES IDENTIFIED IN THE PLAN SHALL BE OBSERVED TO ENSURE THAT THEY ARE OPERATING CORRECTLY. WHERE DISCHARGE LOCATIONS OR POINTS ARE ACCESSIBLE, THEY SHALL BE INSPECTED TO ASCERTAIN WHETHER EROSION CONTROL MEASURES ARE EFFECTIVE IN PREVENTING SIGNIFICANT IMPACTS TO RECEIVING WATERS. LOCATIONS WHERE VEHICLES ENTER OR EXIT THE SITE SHALL BE INSPECTED FOR EVIDENCE OF OFF-SITE SEDIMENT TRACKING.
11. DURING CONSTRUCTION OF THE PROJECT, SOIL STOCKPILES AND BORROW AREAS SHALL BE STABILIZED OR PROTECTED WITH SEDIMENT TRAPPING MEASURES. THE SUBCONTRACTOR SHALL BE RESPONSIBLE FOR THE TEMPORARY PROTECTION AND PERMANENT STABILIZATION OF ALL SOIL STOCKPILES ON SITE AS WELL AS BORROW AREAS AND SOIL TRANSPORTED FROM THE PROJECT SITE.
12. BASED ON THE RESULTS OF THE INSPECTION, THE DESCRIPTION OF POTENTIAL POLLUTANT SOURCES IDENTIFIED IN THE PLAN AND POLLUTION PREVENTION MEASURES IDENTIFIED IN THE PLAN SHALL BE REVISED AS APPROPRIATE AS SOON AS PRACTICABLE AFTER SUCH INSPECTION. SUCH MODIFICATIONS SHALL PROVIDE FOR TIMELY IMPLEMENTATION OF ANY CHANGES TO THE PLAN WITHIN SEVEN (7) CALENDARS FOLLOWING THE INSPECTION.
13. STRAW WATTLE DITCH CHECKS SHALL BE PROVIDED AT 100 FT. ON CENTERS IN NEW AND EXISTING DITCHES.
14. COORDINATES SHOWN ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BEFORE THE START OF CONSTRUCTION.
15. FOR DETAILS OF EROSION CONTROL MEASURES, SEE EROSION CONTROL DETAILS ON DWG. SESCP-2, SPECIFICATIONS SECTION 02370, AND PROJECT SWPPP.
16. TEMPORARY SEEDING AND MULCHING SHALL BE CONSISTENT WITH ARTICLE 880 OF ILLINOIS URBAN MANUAL SEED MIXTURE.
17. STABILIZATION OF DISTURBED AREAS SHALL BE IN ACCORDANCE WITH NPDES PERMIT NO. ILR10 AND THE PROJECT SPECIFIC SWPPP INCLUDED WITH EXHIBIT A.
18. HAUL ROADS SHALL BE WATERED FOR DUST CONTROL DURING EARTH MOVING OPERATIONS.
19. NECESSARY DEWATERING SHALL BE PERFORMED AS PER FERMILAB SPECIFICATION 02220 ITEM 3.03-D.

REV.	DATE	DESCRIPTIONS
		REVISIONS

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DRAWN	K. CUSSEN	03/03/14
CHECKED	A. VASONIS	03/03/14
APPROVED	M. SHRADER	03/03/14
SUBMITTED		

PROJECT NORTH
TRUE NORTH
W E S

SCALE:
1" = 40'-0"
40 0 40 80
SCALE FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

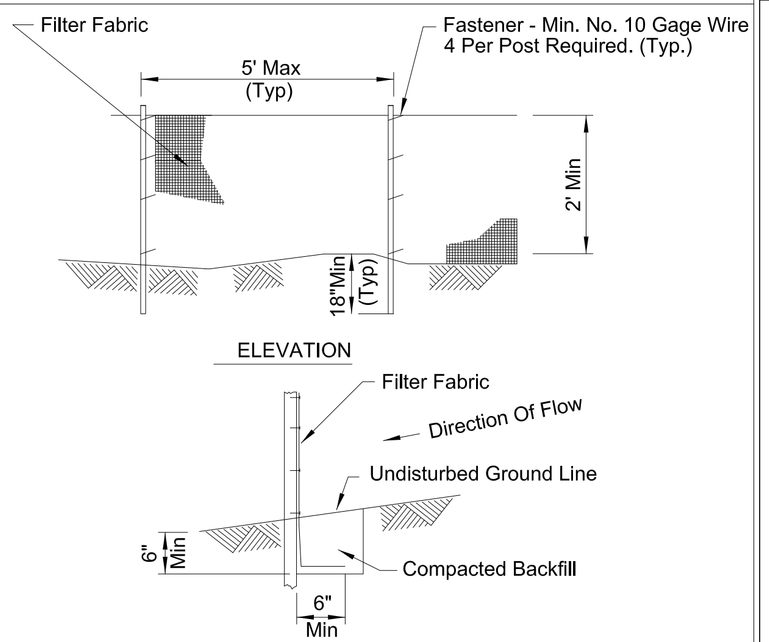
F.I.M.S. No.

Mu2e CONVENTIONAL FACILITIES
&
MC BEAMLINE ENCLOSURE
SOIL EROSION AND SEDIMENT CONTROL PLAN

DRAWING NO. 6-10-2 / 6-10-22 **SESCP-1** REV.

03 MAR 2014

SILT FENCE PLAN

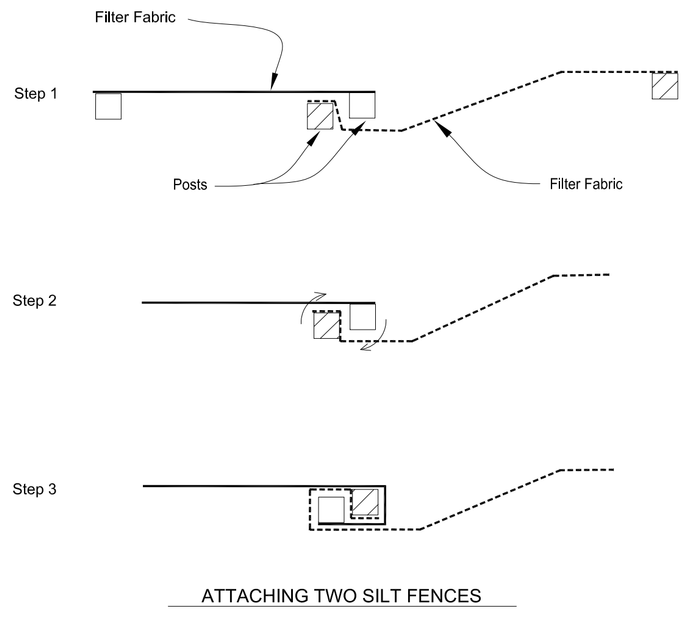


NOTE: AN APPROVED SILT FENCE IS GEOFAB, ENVIROFENCE.

NOTES:
1. Temporary sediment fence shall be installed prior to any grading work in the area to be protected. They shall be maintained throughout the construction period and removed in conjunction with the final grading and site stabilization.
2. Filter fabric shall meet the requirements of material specification 592 Geotextile Table 1 or 2, Class with equivalent opening size of at least 30 for nonwoven and 50 for woven.
3. Fence posts shall be standard wood post with a minimum dimensions of 1.125 in x 1.125 in x 42 in.

REFERENCE		NRCS	STANDARD DWG. NO.
Project		Natural Resources Conservation Service	IL-620
Designed	Date		SHEET 1 OF 2
Checked	Date		DATE 11-20-01
Approved	Date		

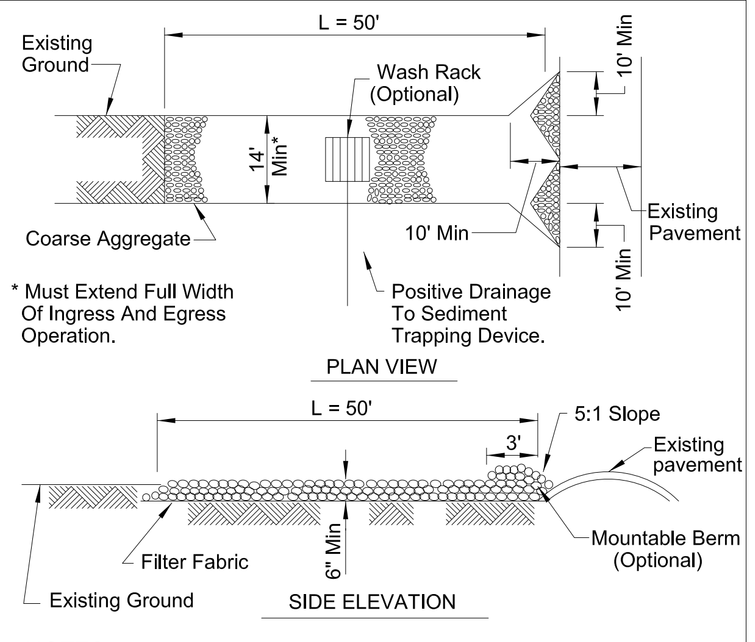
SILT FENCE



NOTES:
1. Place the end post of the second fence inside the end post of the first fence.
2. Rotate both posts at least 180 degrees in a clockwise direction to create a tight seal with the fabric material.
3. Drive both posts a minimum of 18 inches into the ground and bury the flap.

REFERENCE		NRCS	STANDARD DWG. NO.
Project		Natural Resources Conservation Service	IL-620(W)
Designed	Date		SHEET 2 OF 2
Checked	Date		DATE 1-29-99
Approved	Date		

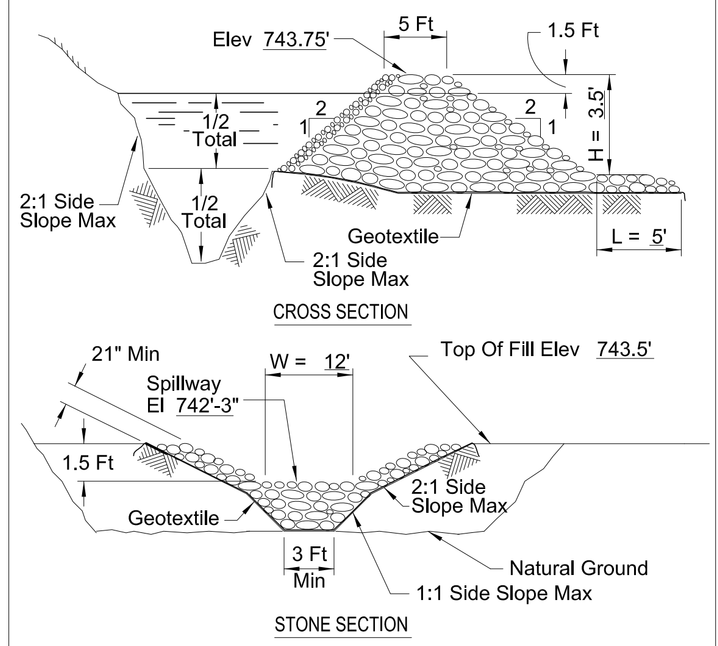
STABILIZED CONSTRUCTION ENTRANCE PLAN



NOTES:
1. Filter fabric shall meet the requirements of material specification 592 GEOTEXTILE, Table I or 2, Class I , II or IV and shall be placed over the cleared area prior to the placing of rock.
2. Rock or reclaimed concrete shall meet one of the following IDOT coarse aggregate gradation, CA-1, CA-2, CA-3 or CA-4 and be placed according to construction specification 25 ROCKFILL using placement Method 1 and Class III compaction.
3. Any drainage facilities required because of washing shall be constructed according to manufacturers specifications.
4. If wash racks are used they shall be installed according to the manufacturer's specifications.

REFERENCE		NRCS	STANDARD DWG. NO.
Project		Natural Resources Conservation Service	IL-630
Designed	Date		SHEET 1 OF 2
Checked	Date		DATE 8-18-94
Approved	Date		

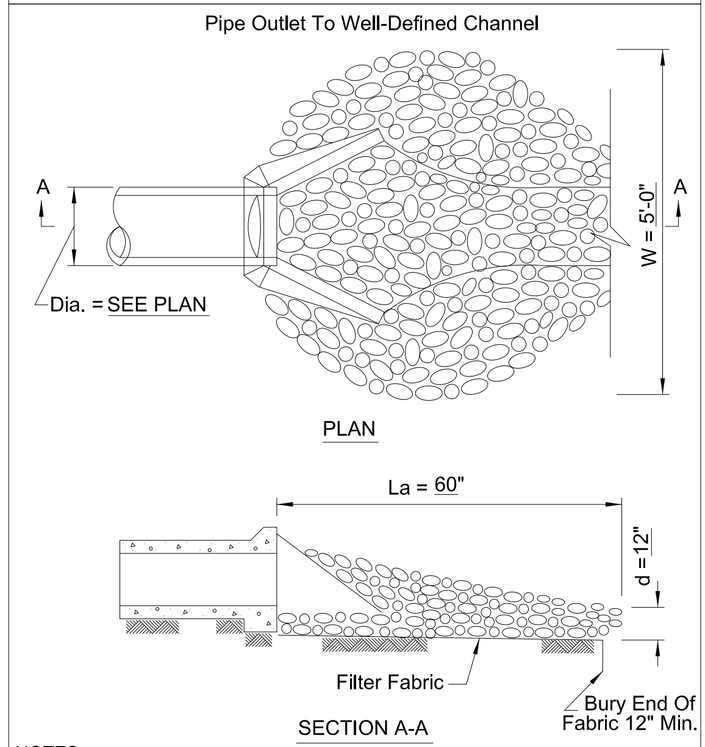
TEMPORARY SEDIMENT TRAP



NOTES:
1. If the sediment pool is formed or enlarged the side slope will be 2:1 or flatter.
2. The fill shall be constructed using IDOT RR-4 stone size. A 1'layer of IDOT CA-2 should be placed on the inside face to reduce the flow rate. The rock will be placed according to construction specification 25 ROCKFILL.
3. Placement will be by Method 1 and compaction will be class III.
4. The geotextile shall meet the requirements in material specification 592 GEOTEXTILE table 1 or 2, class I , II or IV.

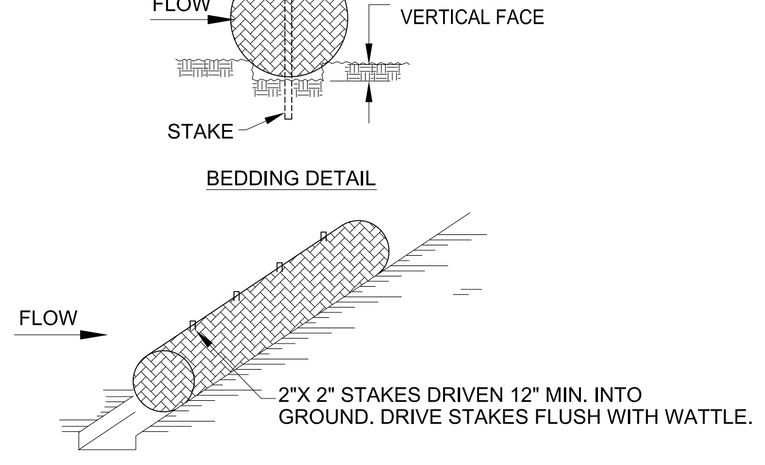
REFERENCE		NRCS	STANDARD DWG. NO.
Project		Natural Resources Conservation Service	IL-660
Designed	Date		SHEET 1 OF 1
Checked	Date		DATE 11-20-01
Approved	Date		

PIPE OUTLET PROTECTION



NOTES:
1. The filter fabric shall be as specified in Section 1080.03 of IDOT Standard Specifications.
2. Riprap shall be supplied to the quality and gradation requirements of Section 1005.01 of IDOT Standard Specifications.
3. The riprap shall be installed per Section 281.04 of IDOT Standard Specifications.

REFERENCE		NRCS	STANDARD DWG. NO.
Project		Natural Resources Conservation Service	IL-611
Designed	Date		SHEET 1 OF 1
Checked	Date		DATE 8-18-94
Approved	Date		REV: 9-21-09 CPD

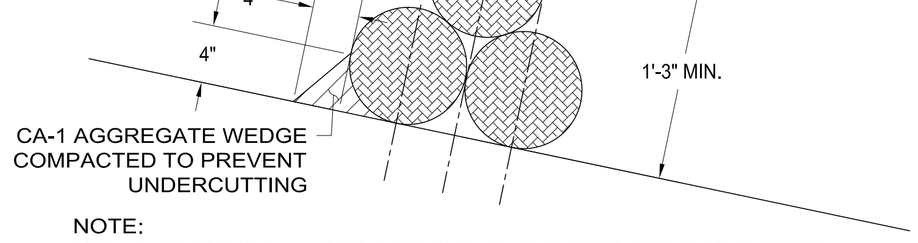


NOTES:
1. STRAW WATTLES SHALL BE A MINIMUM OF 9" IN DIAMETER. WATTLES SHALL CONSIST OF 100% CLEAN, CERTIFIED WEED FREE STRAW FIBER MATRIX CONFINED BY A SYNTHETIC NET.
2. REMOVE DEBRIS, ROCKS AND CLODS AND GRADE TO CREATE A SMOOTH FLAT SURFACE TO INSTALL WATTLE ON. EXCAVATE A TRENCH APPROXIMATELY 3 INCHES DEEP TO SET WATTLE IN. BACKFILL AND COMPACT SOIL AROUND WATTLE. STAKES SHALL NOT STICK OUT MORE THAN 4" ABOVE THE TOP OF THE WATTLE.
3. OVERLAP WATTLES 6" AT JOINTS BETWEEN WATTLE LOGS.
4. INSPECT ON A ROUTINE BASIS. MAKE REPAIRS IMMEDIATELY. SEDIMENT SHALL BE
5. REMOVED WHEN IT REACHES 3" HIGH ON THE WATTLE. IF WATTLE NETTING HAS DETERIORATED DUE TO ULTRAVIOLET BREAKDOWN OR VEHICLE DAMAGE, IT SHALL BE REPLACED.

STRAW WATTLES

SCALE: NTS

1

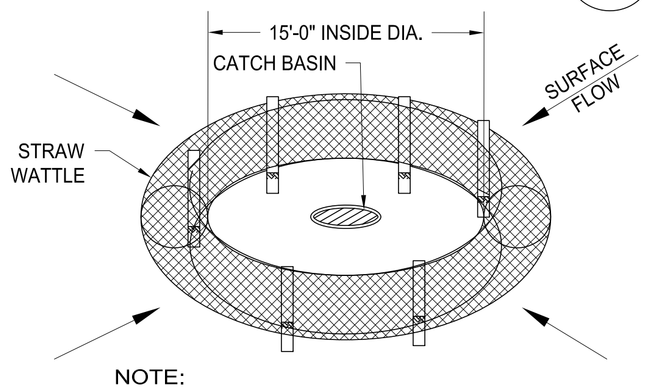


NOTE:
DITCH CHECK DAMS SHALL BE PLACED SUCH THAT THE TOP OF THE DOWNSTREAM CHECK DAM IS AT THE SAME ELEVATION AS THE TOE OF THE ADJACENT UPSTREAM CHECK DAM.

DITCH CHECK

SCALE: NTS

2

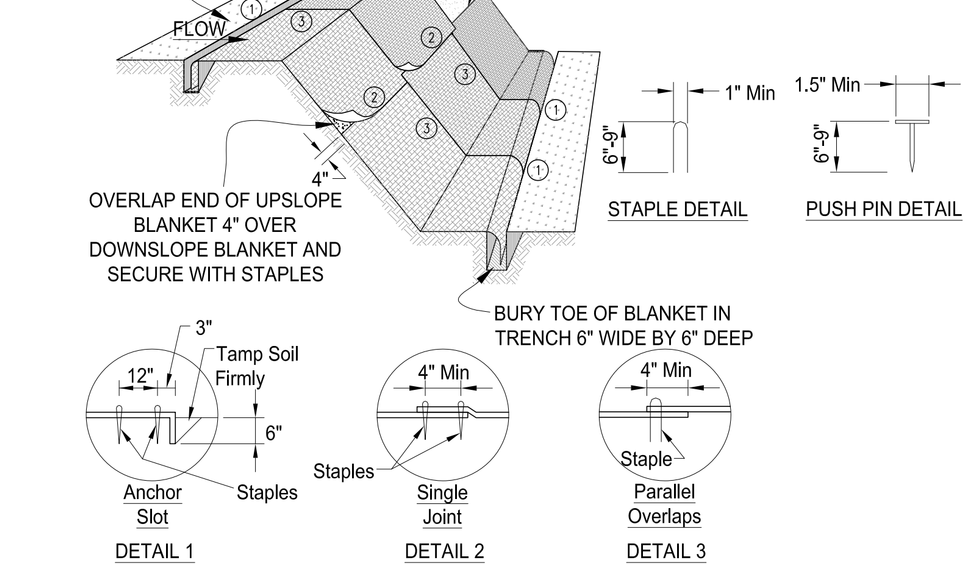


NOTE:
FOLLOW STRAW WATTLE DETAIL TO PROPERLY INSTALL STRAW WATTLE AROUND CATCH BASINS.

INLET PROTECTION

SCALE: NTS

3

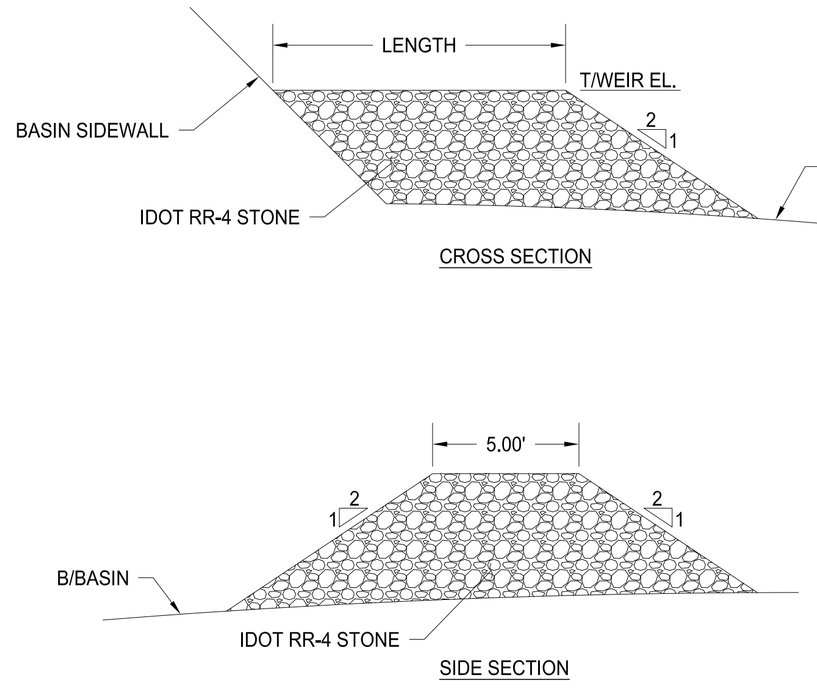


NOTES:
1. STAPLES SHALL BE PLACED IN A DIAMOND PATTERN AT 2 PER S.Y. FOR STITCHED BLANKETS. NON-STITCHED SHALL USE 4 STAPLES PER S.Y. OF MATERIAL. THIS EQUATES TO 200 STAPLES WITH STITCHED BLANKET AND 400 STAPLES WITH NON-STITCHED BLANKET PER 100 S.Y. OF MATERIAL.
2. STAPLE OR PUSH PIN LENGTHS SHALL BE SELECTED BASED ON SOIL TYPE AND CONDITIONS. (MINIMUM STAPLE LENGTH IS 6")
3. EROSION CONTROL MATERIAL SHALL BE PLACED IN CONTACT WITH THE SOIL OVER A PREPARED SEEDBED.
4. ALL ANCHOR SLOTS SHALL BE STAPLED AT APPROXIMATELY 12" INTERVALS.

EROSION CONTROL BLANKET

SCALE: NTS

4



ROCK WEIR

SCALE: N.T.S.

5

REV.	DATE	DESCRIPTIONS
		REVISIONS

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DRAWN	K. CUSSEN	03/03/14
CHECKED	A. VASONIS	03/03/14
APPROVED	M. SHRADER	03/03/14
SUBMITTED		

PROJECT NORTH
TRUE NORTH
W E S

SCALE:

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

Mu2e CONVENTIONAL FACILITIES & MC BEAMLINE ENCLOSURE EROSION CONTROL DETAILS

DRAWING NO. 6-10-2 / 6-10-22 SESCP-2 REV.

F.I.M.S. No.
03 MAR 2014

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Appendix E: Site Specific Construction Safety and Health Plan

Site Specific Construction Safety and Health Plan

(SSCSHP)

for the

Mu2e Project
Part 1; WBS 3.0, Conventional Construction

Additional Parts will be issued for technical work

At

Fermi National Laboratory

For the

U.S. DEPARTMENT OF ENERGY

Office of Science

July 14, 2014

Site Specific Construction Safety and Health Plan (SSCSHP)
for the
Mu2e Project

INSTRUCTIONS

A Site Specific Construction Safety and Health Plan[1] (SSCSHP) is required for each construction project at Fermi National Laboratory (Laboratory). The plan prepared for the Mu2e conventional construction projects by the General Subcontractor (Subcontractor) will be reviewed and approved by the Laboratory personnel managing the Mu2e conventional construction projects.

The purpose of the SSCSHP required of the Subcontractor is to demonstrate that they have a clear understanding of the safety hazards inherent in the construction approach (Means & Methods) they anticipate being applied on the project. The development of the SSCSHP should begin with a baseline hazards assessment which identifies the potential hazards the Subcontractor anticipates encountering in the performance of the proposed contract. With this information the Subcontractor then develops a SSCSHP, which is tailored to the project's specific environment, safety and health hazards. The plan must address the Subcontractor's work planning and control process including the requirement for the development of Hazard Analyses (HA) for each work activity performed on site. This plan is also to identify the competent and responsible personnel for the implementation and stewardship of the plan.

The questionnaire attached to this document is intended to provide the Laboratory with an understanding of the hazards the Subcontractor anticipates encountering and to provide the Subcontractor with insight into the safety controls the Laboratory will impose in specific areas. The Subcontractor may use the questionnaire as a template for the development of its SSCSHP or attach it to their SSCSHP.

The SSCSHP is to be submitted to the Laboratory for its review and approval. Once the SSCSHP has been approved the Laboratory will issue the Subcontractor the Authorization to start work (via a Notice to Proceed). Neither the Subcontractor nor its Sub-Subcontractors may perform any physical work at the Laboratory prior to the Subcontractor receiving the Notice to Proceed.

The Subcontractor must flow down the safety requirements of the Mu2e Conventional Facilities Contract to each of its Sub-Subcontractors. The Subcontractor has the option of requiring all its Sub-Subcontractors' activities to be conducted under the Subcontractor's umbrella SSCSHP or steward each Sub-Subcontractor's SSCSHP which has been reviewed and approved by the Laboratory.

[1] **Safety** means Environment, Safety & Health

To further assist the Subcontractor the Mu2e Project has developed a *Site Specific Construction Safety and Health Plan - Guide* ("*SSCSHP Guide*") which defines the minimum ESH expectations that must be incorporated into the Subcontractor's own SSCSHP to ensure that Laboratory-specific requirements are met and incorporated into the project planning process. These ESH expectations are communicated to the Subcontractor via the Exhibit A and it's Addendum A.

The Laboratory's SSCSHP - Guide is a living document which will be updated as standards and accepted practices change in the construction industry. The Subcontractor is expected to make commensurate changes within their own SSCSHP when the Mu2e's Site Specific Construction Safety Guide is updated. The Subcontractor is also expected to up-date their SSCSHP as new information regarding hazards are identified through the evolution of the project.

There are three parts to this SSCSHP template.

Part 1 All sections are required to be completed for each construction project, regardless of the size or complexity.

Part 2 All sections are to be checked and filled in as applicable for the project's scope of work. For those sections that are not applicable, enter "N/A" or other suitable explanation.

Part 3 A Hazard Analysis (HA), is required for all projects, regardless of the size, scope or complexity of work. This is the heart of the project's safety information, and serves as a work control document. Every project has at least one definable construction activity, and therefore at least one HA. Depending upon the complexity of the project, one or several HAs may need to be developed. In some cases, HAs may need to be staged, in coordination with the initiation of the various phases of a project.

PART 1 – PROJECT GOVERNANCE / EMERGENCY INFORMATION

Section 1 – Project Description and Emergency Contacts

Fill in the names and telephone numbers of the contact personnel for this particular project. In accordance with 10 CFR 851, the Subcontractor's designated on-site safety representative must be knowledgeable of the project's hazards, understand how to mitigate those hazards and have the authority to correct unsafe conditions or behavior. Attach the qualifications of the safety representative for this project (see section 9). Contact information must also be provided for Sub-Subcontractors performing work on this project. This information must be update as necessary throughout the project.

Attach a site map showing assembly points and directions to your authorized medical facility (as the last page of your SSCSHP to facilitate easy removal for transport). A copy must also be posted at the project field location. Upon award of the work, contact the Laboratory for electronic copies of building evacuation routes and assembly areas to include in your map(s), as needed, where work is done inside buildings.

Refer to Chapter 2 of the *SSCSHP Guide* for additional information.

Section 2 – Subcontractor Policy Statement

Enter your Company's health and safety policy statement. At minimum, your policy should include:

- Specific statement of intent to comply with the code of federal regulations, Title 29, Part 1910, General Industry Safety and Health Standards and Part 1926, Safety and Health Standards for the Construction Industry, 10 CFR 851, Worker Safety and Health and other applicable codes and standards.
- A statement that all requirements of the plan apply to all lower tier Subteir Subcontractors, and must be flowed down to all Sub-Subcontractors at all levels.
- Statement of employee's rights and responsibilities regarding a safe and healthful work environment in accordance with the work site OSH poster (i.e. OSHA/DOE poster or equivalent).
- Statement of Stop Work Authority for all workers.

Refer to Chapter 2 of the *SSCSHP Guide* for additional information regarding program policies.

Section 3 – 10 CFR 851 Acknowledgement

Because the Laboratory is a Department of Energy site, the Subcontractor must meet the requirements of Title 10, *Code of Federal Regulations*, "Energy", Part 851, "Worker Safety and Health Program" (Link to 10 CFR 851). It is the Subcontractor's responsibility to ensure it has read and understands the actual regulatory requirements.

Refer to Chapter 2 of the *SSCS Guide* for additional information regarding program policies.

Section 4 – Safety Briefings and Inspection

The Subcontractor must conduct periodic safety briefings and inspections, based upon the duration and complexity of the project. Describe the frequency and initiation of safety briefings and inspections on your project at the Laboratory.

Refer to Chapter 5.0 of the *SSCSHP Guide* for additional information regarding minimally-required inspections and briefings.

PART 2 – PROJECT CHARACTERIZATION

Section 5 – Project Characterization

Under 10 CFR 851, Subcontractors must identify existing and potential workplace hazards and assess the risk of associated workers injury and illness. This section will help to serve as first step in characterizing your project and the associated hazards, and will aid in the development of the HA(s).

List the project's Definable Work Activities: A definable work activity is a task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment.

Add additional lines as necessary to identify all the definable construction activities of your project. Refer to Chapter 4.0 of the *SSCSHP Guide* for additional information regarding Definable Work Activities.

Check all of the Hazards/Activities that apply to your project: The checklist in this section includes those activities which are subject to Laboratory-specific controls beyond what is required by OSHA standards, or have the potential to affect natural resources including storm water, wetlands, streams, air quality, vegetation and wildlife. In the left-hand column, check all activities that will be performed as part of this project. Identify your Competent Person(s) where applicable. Refer to the corresponding Chapters of the *SSCSHP Guide* for additional information on each topic area.

This checklist is presented in part for project planning and scheduling purposes, as some activities require Laboratory-specific permits to be acquired prior to the Subcontractor being allowed to perform them. If your project involves an activity that has a check in the right-hand column, then your SSCSHP must include a copy of your company program that addresses the controls and requirements for performing that activity at the Laboratory. If your company does not have an established program for a particular activity, then you may attach a project-specific program/plan for performing that activity at the Laboratory or address it in sufficient detail in a thorough HA (however, this is not an option for OSHA-required programs). Use Section 9 of this template to list and identify attachments of your company programs, policies, procedures and/or plans. Be specific as to the chapter and/or section being referenced.

Project-applicable activities that have potential environmental impacts will require Laboratory ESH coordination and concurrence, as identified in Chapter 18 of the *SSCSHP Guide*. The Subcontractor and all lower-tier Sub-Subcontractors are responsible for implementation and compliance with all federal, state and local laws as well as Laboratory procedures.

Details of Laboratory-specific requirements are presented in the labortory's SSCSHP Guide. The Subcontractor is responsible for knowing and abiding by the requirements of the *SSCSHP Guide*.

Section 6 – Project Support Features, Site Control and Logistics

Address important site/project control elements that you will employ on your project such as signs, barricades, fencing, briefings, sign-in/out logs, blocked exits, PPE postings, etc. Attach a diagram showing: construction areas, laydown areas, staging areas, alternative exit routes, material storage areas, pedestrian routes, traffic control, material receiving areas, etc. Attach a copy of your Logistics Plan to delineate your site control procedures. Use Section 9 of this template to identify in which appendix the Logistics Plan appears in your SSCSHP.

Section 7 –Required Training/Qualification

Check all boxes applicable to this Project's work scope.

Where specific training is required (e.g. – OSHA mandated), the Subcontractor must maintain, on-site, proof of the particular individuals meeting, and being current in, the training

requirements. Identify where you will maintain those records on the Laboratory Site. Refer to Chapter 2.0 of the *SSCS Guide* for additional training requirements information.

Section 8 – Hazard Communication

Hazardous chemicals (as defined in 29 CFR 1910.1200) to be brought or used on-site are to be identified and managed appropriately. The Subcontractor is responsible for maintaining an up-to-date chemical inventory (only of those chemicals brought on site), and copies of Safety Data Sheets (SDS) must be maintained at the task or project support facilities and made available for review by site workers, the DOE, Laboratory employees, and Laboratory designated representatives.

Identify the methods you will use to inform the other employer(s) of any precautionary measures that need to be taken to protect Laboratory and/or other Sub-Subcontractor employees during normal operating conditions and in foreseeable emergencies.

Identify the methods you will use to inform other affected workers of your labeling system if the labeling system is not readily understandable.

If your existing Hazard Communication Program addresses these requirements, you may attach a copy of it and your project-specific chemical listing instead of filling out the block in this Section (9).

Refer to Chapter 15.0 of the *SSCSHP Guide* for additional information regarding the Laboratory's Hazard Communication requirements.

Section 9 – Plan Attachments

A description of the qualifications (or resume) of all individuals serving as the Designated Safety Representative(s) on this project must be included in the Plan, per 10 CFR 851.

Additionally, if your project involves a hazard/activity that has a check in the right-hand column of Section 5, then your SSCSHP must include a copy of your company's program addressing that topic. Alternatively, your company may submit a project-specific plan/HA that details your approach to addressing that topic. You are responsible for ensuring that your project-specific controls are in alignment with the Laboratory site requirements presented in the *SSCSHP Guide*, either via your company program or through specific controls identified in the project HAs.

Use this Section of this template to also list any other plans(s)/procedures you are attaching to this SSCSHP. Hardcopies and/or an electronic file or hyperlink to these documents must be reference here.

PART 3 – HAZARD ANALYSES

10 CFR 851, Appendix A to Part 851 – Worker Safety and Health Functional Areas, Construction Safety requires that a Hazard Analysis (HA) be prepared for each separately definable construction activity (e.g., mobilization, excavations, concrete/foundations, structural steel, roofing) prior to the commencement of work. For larger projects, the primary Subcontractor may

either flow down this requirement to each of its lower-tier subSubcontractors, or serve as a single control and coordination point for all project HA's.

Prior to the start of each phase of work, it will be the responsibility of the Subcontractor to develop a thorough HA that details the hazards and controls for the steps associated with that phase of work, and submit it to the Laboratory for review and approval.

If the project's complexity and/or schedule require several HAs to be developed for different phases of the Project, the Subcontractor may use the tracking table as a tool to coordinate which HAs are in effect and which HAs are yet to be developed.

The SSCSHP template is provided in electronic format to enable copy-and-paste functions for those Subcontractors whose basic data remains unchanged, yet allow for the work steps, hazard and controls information to be tailored to the particular activities/materials/location of the project at-hand. The HA template rows can be expanded to include additional tasks, or reduced in number to accommodate changes, and to vary the final product to match the relative complexity of the project.

Refer to Chapter 4.0 of the *SSCSHP Guide* for additional information regarding the Laboratory's Hazard Analyses requirements.

Emergency Assembly Points and Medical Map

A site map showing assembly points and directions to your authorized medical facility is to be provided (as the last page of your SSCSHP to facilitate easy removal for transport). A copy must also be posted at your project field location. Upon award of the work, contact the Laboratory Construction Manager or Mu2e Safety Lead for electronic copies of building evacuation routes and assembly areas to include in your map(s), as needed.

Part 1

(Project Name)

Site Specific Construction Safety and Health Plan

SECTION 1 - PROJECT DESCRIPTION & EMERGENCY CONTACTS		
Subcontract / Purchase Order Number	Enter subcontract and/or task order number	
Project Start / End Dates	Start:	Complete:
Project Location	Enter the work location(s) at Fermilab	
Scope of Work	Enter breakdown and description of work activities	

FOR ALL EMERGENCIES CALL:

Fermilab Emergency Contact number: 3131 - or - (630) 840-3131 from a cell phone.

For all incidents, injuries, property damage, near-misses, work-induced illness or chemical over-exposures, the following personnel MUST be immediately contacted upon scene stabilization, but in all cases within one hour:

Project Personnel	Name	Phone Number(s)	Email
Fermilab Construction Manager	Enter name of Fermilab Project Manager	Enter number: xxx-xxx-xxxx	Enter: user@domain
Fermilab Mu2e Construction Coordinator or Task Manager	Enter name of Fermilab ESH POC	Enter number: xxx-xxx-xxxx	Enter: user@domain
OTHER CONTACT INFORMATION			
Subcontractor Project Manager	Enter the name of Subcontractor Project Manager	Enter number: xxx-xxx-xxxx	Enter: user@domain
Subcontractor Site Superintendent	Enter the name of Subcontractor's Site Superintendent	Enter number: xxx-xxx-xxxx	Enter: user@domain
Subcontractor Safety & Health Representative **	Enter the name of Subcontractor health & safety representative	Enter number: xxx-xxx-xxxx	Enter: user@domain

SubSubcontractors - Company Name	Name of Designated Safety Representative **	Phone Number
Enter SubSubcontractor company name	Enter name of individual**	Enter number: xxx-xxx-xxxx
Enter Subtier company name	Enter name of individual**	Enter number: xxx-xxx-xxxx
Enter Subtier company name	Enter name of individual**	Enter number: xxx-xxx-xxxx

*** Attach a description of qualifications, or resume, for each Safety Representative per Section 9.0.*

SSCSHP REVIEWS		
Reviewed & Approved by: (Subcontractor Company Officer)	Subcontractor SSCSHP Reviewed & Concurred by: (Fermilab)	Subcontractor SSCSHP Reviewed & Concurred by: (Fermilab)
Enter Subcontrator - Company Officer	Enter Fermilab Project Manager	Enter Fermilab MU2E CONVENTIONAL FACILITIES Safety Lead
Signatures and dates		

A map of Emergency Assembly Points and Fermilab Medical Office is attached to back of this Plan and posted at the work site.

SECTION 2 - SUBCONTRACTOR POLICY STATEMENT

SECTION 3 - ACKNOWLEDGMENT of 10 CFR 851

As a subSubcontractor to the Laboratory, while your workers are physically located at the Laboratory you must meet the requirements of Title 10, *Code of Federal Regulations*, "Energy", Part 851, "Worker Safety and Health Program" (10 CFR 851). As such, you must be aware of, and comply with, the requirements of this regulation. (Link to 10 CFR 851)

Acknowledgment	I, (the author of this SSCSHP), certify that that I have read the requirements of 10 CFR 851 and attest that my firm and its sub-tier Subcontractors will comply with the requirements of 10 CFR 851.	Yes ☐	No ☐

MEDICAL SURVEILLANCE AND QUALIFICATION

Occupational Medicine	Will you have any employees that will work on-site at Fermilab for 30, eight-hour days in a 12-month period, or are enrolled for any length of time in a medical or exposure monitoring program required by federal, state, or local regulations (including hearing conservation, respiratory protection, lead exposure)? *Refer to the SSCSHP Guide, Section 3.0 for additional information.*	Yes ☐	No ☐
	If yes, you will need to: 1. Comply with the occupational medicine requirements of 10 CFR 851, Appendix A 2. Provide your occupational medicine provider contact information		

Clinic / Physician	Enter the name and address of your company's medical provider for this project	Enter telephone number: xxx-xxx-xxxx	Enter e-mail address: user@domain

Required Medical Surveillance		Task-specific medical testing
☐ DOT/Commercial Vehicle	☐ Blood Lead	List specific task(s) requiring medical surveillance
☐ Hearing Conservation	☐ Respirator User	
☐ Fit For Duty	☐ Other(s) :List other(s)	
☐ Substance Abuse Testing		

SECTION 4 - SAFETY BRIEFINGS AND INSPECTIONS
Safety Briefings: Discuss the conduct of safety briefings on your project at Fermilab
Safety Inspections: Discuss your conduct of safety inspections during this project at Fermilab
Refer to the SSCSHP Guide, Section 5.0 for additional information.

Part 2

SECTION 5 – PROJECT CHARACTERIZATION

Identify the project's Definable Work Activities.

(e.g., mobilization, excavations, concrete, structural steel erection, dry-walling, electrical install, painting, roofing, landscaping, etc.)

Mobilization (-describe as necessary)	Anticipated Start Date
Enter Activity	Anticipated Start Date
Enter Activity	Anticipated Start Date
Enter Activity	Anticipated Start Date
Enter Activity	Anticipated Start Date
Enter Activity	Anticipated Start Date
Enter Activity	Anticipated Start Date

Check all of the hazards/activities below that apply to this Project. Refer to the *SSCSHP Guide* for Fermilab-specified controls.

Yes	No	Hazard/Activity with specific Fermilab-based control measures.		Fermilab-issued Permit required	Attach copy of Subcontractor Program or Project Plan addressing this activity
☐	☐	Asbestos use, alteration, removal or storage (Asbestos Abatement Plan)		✓	✓
		(Identify your Competent Person for Asbestos Work here)			
☐	☐	Blocking Exits or Exit Pathways			✓
☐	☐	Building Surface Penetration		✓	✓
☐	☐	Confined spaces (Confined Space Entry Plan)		✓	✓
☐	☐	Crane Use		✓	✓
		(Identify your Lift Supervisor here)			
☐	☐	Discharges to sanitary/septic system will occur			
☐	☐	Energized electrical work (>50 v or > 50 mA) (Energized Electrical Work Permit)		✓	✓
☐	☐	Excavation (Dig Permit)		✓	✓
		(Identify your Competent Person for Excavations here)			
☐	☐	Falls from elevation (work at heights > 6 feet) (Fall Protection Plan)			✓
		(Identify your Fall Protection Equipment Competent Person here)			

☐	☐	Fire protection system outage or modification		✓	✓
☐	☐	Flushing of waterlines, storm/sanitary lines, fire suppression systems or fire hydrants will be performed			
☐	☐	Hazardous Waste Storage or generation on construction site			✓
☐	☐	Hoisting/Rigging (Hoisting and Rigging Plan for Critical Lifts)			✓
		(Identify your Hoisting/Rigging Competent Person here)			
☐	☐	Hot work (Open Flame Permit)		✓	✓
☐	☐	Lasers. (Class 3B and 4)		✓	✓
☐	☐	Lead concerns			✓
		(Identify your Competent Person for Lead work here)			
☐	☐	Penetration and Coring (Coring Checklist)		✓	
☐	☐	Radioactive materials or Ionizing radiation-generating devices		✓	✓
		(Identify yourRadiation Safety Officer here)			
☐	☐	Scaffolding			✓
		(Identify your scaffolding Competent Person here)			
☐	☐	Structural Steel Erection			✓
☐	☐	Traffic Control			✓
☐	☐	Respiratory Protection Plan			✓

SECTION 6 - PROJECT SUPPORT FEATURES, SITE CONTROL & LOGISTICS

Check all of the following facilities and equipment that are required for safe completion of work.

Facility/Equipment	Description
☐ Project Office	Describe office to be used (room/trailer, location, etc.)
☐ Materials Receiving Location	Describe (location, size, delivery times, etc.)
☐ Portable Restrooms/wash stations	Describe (number, location, etc.)
☐ Supplementary Illumination	Describe Supplementary Illumination (Type(s), indoor/outdoor, distribution, etc.)
☐ Emergency Eyewash/Shower	Describe (type, location, distribution, etc.)
☐ First Aid Supplies	Describe (type,size, location,etc.)

☐ Fire Extinguishers	Describe (type,size, location,etc.)
☐ Hazardous Material Storage	Describe (materials, amounts, location, etc.)
☐ Spill Containment/Clean-up	Describe (materials, location, etc.)
☐ Other: Enter Other Type	Describe item, location, number, etc.
☐ Other: Enter Other Type	Describe item, location, number, etc.

Site Control / Logistics	
Task / Location	Specify your task-specific site control/access control measures below.
Enter work task and location	Enter specific site/area control procedure
Enter work task and location	Enter specific site/area control procedure
Enter work task and location	Enter specific site/area control procedure
☐ Check here if you are ALSO attaching a Logistics Plan for your activities. Logistics Plan is attached in Appendix #___	

SECTION 7 – REQUIRED TRAINING/QUALIFICATIONS

Training Records Location:

Identify where you will maintain training/certification records related to your Project at Fermilab

Identify the activities involved on your project which have OSHA-required training:

Yes	No	
☐	☐	Asbestos activities
☐	☐	Aerial Lift Operation
☐	☐	Crane Operation (minimum NCCCO certification for operator)
☐	☐	Confined Space Entry
☐	☐	Electrical Work requiring NFPA 70E provisions
☐	☐	Electrical Work requiring CPR-trained 2nd worker
☐	☐	Excavation
☐	☐	Fall Protection Equipment
☐	☐	Forklift Operation/Powered Industrial Truck Use
☐	☐	Heavy Equipment Operation List equipment to be used:
☐	☐	Ladder Use
☐	☐	Lock-Out/Tag-Out

☐	☐	Noisy Operations requiring Hearing Conservation training
☐	☐	Scaffolding Erection, Use
☐	☐	Other: (List...)

SECTION 8 - HAZARD COMMUNICATION (HAZCOM)

SDS Location:

Identify where you will maintain your Project Chemical list and SDSs at Fermilab

Method of notifying affected Fermilab employees:

If the chemicals you will use on the project may affect Fermilab employees or other subSubcontractor employees, describe the method you will use to notify them. Describe your method of instructing others about your labelling system, if it is nonstandard.

Refer to the SSCS Guide, Section 15 for additional information.

SECTION 9 - PLAN ATTACHMENTS

For each activity or hazard checked in Section 5, list and attach your additional corporate, site- or project-specific programs/plans.

Attachment	Reference Procedure or Program
1	Project safety representative, Statement of Qualifications for: (insert name)
#	List Reference Procedure or program
#	List Reference Procedure or program
#	List Reference Procedure or program

PART 3 – CONSTRUCTION HAZARD ANALYSES
Complete an Hazard Analysis for each of your project's Definable Construction Activities *Refer to the SSCSHP Guide, Section 4.0 for additional information.* *Construction Hazard Analysis*
Note: A completed, signed HA must be submitted to Fermilab for review and approval prior to the start of each phase of work, in order to proceed with that phase.

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EXHIBIT A
Supplementary Terms and Conditions

This Exhibit A and the corresponding Addendum A together comprise the project specific requirements that are supplementary to the requirements of the Fermilab Subcontract General Provisions contained in FL-1 and the Fermilab Construction Subcontract Terms and Conditions contained in FL-3.

Note
Items and descriptions highlighted (see example below) indicate additional information, descriptions and requirements are contained in Addendum A.

Example:
Refer to **ADDENDUM A, SECTION 1.1** for the specific…

Table of Contents

Exhibit A

1.0 SITE LOCATION

The project is located on the Fermi National Accelerator Laboratory (Fermilab) Site, adjacent to the city of Batavia, Illinois. Refer to **Section 1.0 of Addendum A** for the specific project (work) location on the Fermilab site.

2.0 SCOPE OF WORK

The Subcontractor shall furnish all required supervision, labor, materials, tools, plant and appurtenances necessary to perform diligently and fully all work as described in the drawings and technical specifications. This includes transportation, overhead, bonding costs, safety oversight, quality control oversight, and supervision as required to construct the project described in the drawings, technical specification and the detailed description contained in **Section 2.0 of Addendum A**.

3.0 ITEMS AFFECTING WORK PLANNING

Items affecting the work planning include the specific items listed in **Section 3.0 of Addendum A**. and the following items:

3.1 Existing Utilities, Equipment and Structures

a. Utility Identification and Location:

i. Fermilab will identify through drawings, notations and field locates, the approximate location of known utilities and underground structures;

ii. The information concerning structures and utilities indicated on the drawings are provided in accordance with Section 30 of FL-3;

iii. In accordance with Section 35 of FL-3, the Subcontractor shall protect all existing utilities, equipment and structures during all phases of the work;

iv. Vacuum excavation methods, consisting of air or water to break up the soil and a vacuum device to collect the spoil, shall be used to locate electrical cables and gas lines.

b. Work on Existing Utilities:

i. No work shall be performed on existing in-service utility systems without prior approval and coordination of the system outage by the Fermilab Construction Coordinator;

ii. Pressure shall be relieved on all piping systems before opening up and starting work;

iii. Lockout/Tagout shall be used by the Subcontractor for all valves, blank-offs and relief lines;

iv. "Hot Tap" connections shall not be permitted unless specified by the job and specific procedures have been submitted and accepted by Fermilab;

c. Fermi Access for Information Gathering:

i. Fermilab utilizes a GPS system for on-site mapping and documentation of underground utilities;

ii. The Subcontractor shall provide access for data gathering;

iii. The Subcontractor shall notify the Fermilab Construction Coordinator two (2) working days prior to backfilling.

3.2 Environmental Issues Affecting the Work

Environmental issues affecting the work planning specific to this project can be found in **Section 3.2 of Addendum A**.

3.3 Advance Notice of Work Activities

The following activities require the Subcontractor to provide written notification to the Fermilab Construction Coordinator a minimum of three (3) business days prior to the commencement of work:

a. Interruption of road traffic;

b. Closure of any roads;

c. Connection to or interruption of any existing underground utility;

d. Intended use of ICW from any hydrant;

e. Connection to temporary electric power sources;

f. Request for disablement of fire alarms or related safety devices;

g. Request for disablement of fire protection systems;

h. Intended activity beyond the specified construction limits;

i. Intended access to or work within a confined space;
j. Connection to or interruption of any existing 13.8kV power system;
k. Saw cutting or core drilling at manholes, foundations and paved areas;
l. Excavation activities;
m. Backfilling of underground utilities;
n. Delivery of a radioactive source on the Fermilab site.

Fermilab will provide written notification to proceed on the above listed work activities.

3.4 Subcontractor Use of Radioactive Sources for Testing

The use of radioactive testing sources is subject to monitoring and oversight by Fermilab based on the following:

a. Nuclear density meters will be inspected at the construction site by Fermilab ES&H personnel. Review for Department of Transportation compliance with survey and inspection requirements will be completed at that time;
b. When required by specification, Subcontractor use of radiography sources will require five (5) business days advance notice to the Fermilab Construction Coordinator. During this time, the Subcontractor shall submit to the Fermilab Construction Coordinator documentation showing the Subcontractor's NRC or Agreement State license for the material;
c. When the source is brought to the Fermilab site, Fermilab ES&H staff will meet the subcontractor, escort him/her to the construction site, and monitor the use of the source during the testing activity;
d. Any work with radiography will occur outside normal business hours.

3.5 Identification Badging & Subcontractor Employee Orientation

The Subcontractor employees and sub-tier Subcontractor will be required to obtain identification badging for access onto the Fermilab site, unless otherwise stated in **Section 3.5 of Addendum A**.

a. The Fermilab Construction Coordinator will assist in the process of identification badging;
b. As part of the identification badging process, all employees must complete Fermilab Orientation Training;
c. The orientation and badging efforts require approximately one (1) hour;
d. Once identification badges are obtained, they shall be worn at all times while on the Fermilab site;
e. Deliveries and incidental, escorted work activities under eight (8) hours in duration may be exempted from the badging requirement if approved in advance by the Fermilab Construction Coordinator;
f. Reference **Section 3.5 of Addendum A** for project specific training requirements provided by Fermilab.

3.6 Materials Furnished by Fermilab

Information concerning materials furnished by Fermilab can be found in **Section 3.6 of Addendum A.**

3.7 Buy American Act

Section 3.7 of Addendum A contains information regarding construction materials that are exempt from the Buy American Act as described in Section 25 of FL-3, Fermilab Construction Subcontract Terms and Conditions.

3.8 Services Furnished by Fermilab

Fermilab will furnish the services as described below and/or in **Section 3.8 of Addendum A** to the Subcontractor.

a. Fermilab furnished services shall be coordinated with the Fermilab Construction Coordinator;
b. Fermilab coordinates issuance of permits (see Section 5.6 for additional information);
c. Fermilab coordinates requests for and provides disablement of existing systems;
d. Availability and use of existing Fermilab utility services will comply with Section 37 of FL-3;
e. Electrical Power:
    i. **Section 3.8 of Addendum A** describes the electric power that will be furnished by Fermilab for the Subcontractor's use;
    ii. Installation of the Subcontractor's electrical power distribution shall include ground-fault circuit protection and shall be subject to Fermilab approval;
    iii. Any additional power required not specified in Addendum A shall be furnished and paid for by the Subcontractor.
f. Drinking Water:
    i. **Section 3.8 of Addendum A** describes the drinking water that will be furnished by Fermilab for the Subcontractor's use;
    ii. Drinking water distribution containers shall be approved by Fermilab Construction Coordinator and shall be adequate, clean and shall be dispensed from a fully enclosed potable water container with individual paper drinking cups;
    iii. Any additional potable water required not specified in Section 3.8 of Addendum A shall be furnished and paid for by the Subcontractor.
g. Toilet Facilities:
    i. **Section 3.8 of Addendum A** describes the Fermilab toilet facilities that will be available for the Subcontractor's use;
    ii. When Fermilab toilet facilities are not available to the Subcontractor, the Subcontractor shall provide an adequately serviced chemical toilet for every twenty (20) personnel on the project;
    iii. Toilet type and locations shall be approved by Fermilab.

3.9 Electronic Project Drawings

Fermilab may, at the Subcontractor's request and in accordance with Exhibit "B" specifications, release "electronic" project drawings for use in preparation of shop drawings by the Subcontractor or Sub-tier subcontractors or vendors. These electronic drawings will be distributed to the Subcontractor utilizing Fermilab's current file and media format. Fermilab assumes no responsibility for the information contained in these "electronic" drawings, including, but not limited to: Drawing scale, dimensions, details, accuracy, etc. It is the responsibility of the Subcontractor to verify all information contained in these drawings with actual site conditions.

3.10 Site Access and Hauling

Fermilab site access and hauling shall be subject to the following conditions:

a. Electronic communication devices, such as cell phones, texting devices, laptops, etc. must not be used while driving any motor vehicle on Fermilab's site.
b. All roads shall remain open to emergency traffic at all times;
c. All equipment and vehicles shall be confined to operating along defined construction roads and approved access routes;
d. No overland hauling or off-road travel shall be permitted in order to avoid damage to wetland areas, wooded areas, archaeological sites, survey

monuments or other areas to be preserved in their natural state;

e. Interruption of normal traffic patterns or temporary road closings necessitated by movement of equipment or delivery of materials or utility installations shall require advance notice as outlined in Section 3.3 of this Exhibit A, and shall require proper barricades, signage and flag persons to safely divert normal traffic;

f. Traffic on paved roads shall be restricted to rubber-tired vehicles. Where crawler mounted equipment is required to cross paved roads or areas, the pavement shall be suitably protected from damage to the satisfaction of the Fermilab Construction Coordinator;

g. Dust, debris and litter on any Fermilab roads caused by the Subcontractor's operations shall be removed by the Subcontractor in a manner as directed by the Fermilab Construction Coordinator;

h. Illinois Rules of the Road shall apply to the Subcontractor's use of all existing roads;

3.11 Transportation of Equipment and Materials

Transportation of equipment and materials shall be subject to the following conditions:

a. Transportation of equipment and materials used by the Subcontractor at the job site shall be furnished by the Subcontractor at his own expense;

b. The Subcontractor shall be responsible for minimizing any interference with local traffic, other Subcontractors and Fermilab operations;

c. The Subcontractor shall coordinate the anticipated schedule for major material deliveries and site hauling of excavated materials with the Fermilab Construction Coordinator;

3.12 Parking and Staging Areas

Subcontractor parking and staging areas shall be subject to the following conditions:

a. Parking of the Subcontractor's and the Sub-tier subcontractor's vehicles shall be confined to the Subcontractor's designated construction area or general public parking spaces;

b. The Subcontractor's parking and staging area is described in **Section 3.12 of Addendum A**;

c. No material shall be stored beyond the construction limits unless prior written arrangements have been made through the Fermilab Construction Coordinator.

3.13 Temporary Services and Facilities

Temporary services and facilities shall be subject to the following conditions:

a. Temporary services and facilities required during the construction period shall be furnished, installed, and paid for by the Subcontractor;

b. All installations shall be subject to Fermilab approval;

c. Temporary Lighting shall be installed throughout the project to provide safe access and exit conditions and adequate lighting for the various work operations. The installation shall comply with the National Electrical Code (NFPA 70);

d. Telephone Service for the project will be provided by and paid for by the Subcontractor;

e. Temporary Fire Protection:

   i. Temporary fire protection shall be in accordance with the OSHA 29CFR1926;

   ii. An approved fire extinguisher shall be provided by the Subcontractor on all trucks and similar equipment, at all enclosures, and at on-site construction offices;

iii. Each extinguisher shall be inspected monthly and a date tag certifying adequacy of the charge and workability of the extinguisher shall be affixed;

iv. The Subcontractor shall remove the extinguishers at the conclusion of the job.

f. Temporary Ventilation shall be sufficient to provide a safe working environment for construction personnel. Subcontractor shall provide exhaust and supply air fans, ducting and other equipment as needed.

g. Temporary Heat:

i. Temporary Heating shall include heating devices, protective coverings and temporary enclosures as necessary to protect the work and to provide a safe working environment for personnel;

ii. Coal or kerosene type salamanders, pots or open fires shall not be permitted;

iii. Where permanent heating equipment has been installed and made operational prior to completion of the project, the Subcontractor may request temporary use of such equipment, at no cost, provided it is properly maintained by the Subcontractor and that all required warranties are extended to include the period of use by the Subcontractor prior to Final Acceptance of the project by Fermilab.

h. Temporary Drainage:

i. Temporary Drainage shall be sufficient to remove standing water and prevent flooding;

ii. Subcontractor shall furnish pumping equipment and other dewatering equipment as required for proper operation;

iii. Pump discharges shall be intercepted by silt removal or sedimentation basins before being directed to natural drainage courses and away from adjacent work limits of other subcontractors.

3.14 Off Site Disposal

Off-site disposal shall be subject to the following conditions:

a. All disposal shall be in accordance with Section 38 of FL-3, Fermilab Construction Subcontract Terms and Conditions;

b. Off-site disposal of recycled materials, trash, debris, demolished material, pallets, crates, packing materials, rubbish and all waste material shall be the responsibility of the Subcontractor. The goal for recycling construction and demolition waste is 80% based on weight.

c. The Subcontractor shall furnish all necessary dumpsters or similar containers to prevent dispersion of debris both within and outside of the construction site;

d. Recycling:

i. The Subcontractor shall utilize a recycling waste hauler, obtain a report on percentage recycled by weight from the vendor and submit the report to the Fermilab Construction Coordinator;

ii. The minimum amount of recycled material is 50% as measured by weight;

iii. The Subcontractor shall submit a report that details the percentage, by weight, of recycled materials.

e. Regulated Waste:

i. Where regulated waste is generated (Resource Conservation and

Recovery Act Hazardous, Toxic Substance Control Act, Illinois Special Waste, etc.) the Subcontractor shall immediately notify the Fermilab Construction Coordinator;

ii. Unless specified in **Section 3.14 of Addendum A**, all regulated waste shall be disposed through the Fermilab Hazard Control Technology Team.

3.15 Fermilab Closures

The Fermilab site is closed for major holiday and no construction activities shall occur on these days:

a. New Year's Day – January 1st
b. Martin Luther King Jr. Day – 1st Monday after January 15th
c. Memorial Day – Last Monday in May
d. Independence Day – July 4th
e. Labor Day – 1st Monday in September
f. Thanksgiving Day – 4th Thursday in November
g. Day After Thanksgiving – Friday after Thanksgiving
h. Christmas Eve (1/2 Day) – December 24th
i. Christmas Day – December 25th
j. New Year's Eve (1/2 Day) – December 31st

If any of these holidays occur on a weekend day, a weekday will be used for the holiday.

4.0 PROJECT COORDINATION

This section describes the requirements, responsibilities and expectations for the project coordination aspects of this project.

4.1 Subcontractor's Project Team

4.1.1 Field Superintendent

The Subcontractor shall, at all times during the progress of the work, provide a competent superintendent in accordance with FL-3, Section 10. In addition, the following requirements for the Field Superintendent are described below:

a. The Subcontractor shall provide a competent Field Superintendent, who is the Subcontractor's representative designated for the duration of the project to the running of the day-to-day operations of the work including safety, quality control and sub-tier subcontractor coordination responsibilities.
b. The Field Superintendent shall have knowledge and experience of Occupational Safety and Health Administration (OSHA) and other related safety standards, and has the authority to enforce such standards in the field.
c. The Field Superintendent must be present on the Fermilab project site whenever work activities are ongoing.
d. In the absence of the designated Field Superintendent, the Subcontractor shall identify an alternate individual with similar qualifications acceptable to Fermilab.
e. Should more than one work shift be required on this project, the Subcontractor shall identify and assign a designated individual meeting the above requirements for each work shift.
f. In the event that excavations are part of the project scope, the Subcontractor shall provide a competent person for excavation activities who meets the requirements of OSHA 29 CFR 1926.32 (f).
g. In the event that scaffolding is be utilized during the execution of the project, the Subcontractor shall provide a competent person for scaffolding who meets the requirements of OSHA 29 CFR 1926.32 (f).

4.1.2 Safety Representative

The Subcontractor shall employ a Safety Representative who acts as a properly authorized agent of the Subcontractor, responsible for safety activities of all work sites under this subcontract. Unless stated otherwise in **Section 4.1 of Addendum A**, the Subcontractor's Field Superintendent can function as Safety representative. The Safety Representative shall interface with the

Fermilab Construction Coordinator on all safety matters, and assure the subcontractor does the following:

a. Interface with Fermilab Construction Coordinator on all safety matters;
b. Preparing and submitting Hazard Analyses including revisions and updates;
c. Reviewing and accepting sub-tier safety plans and hazard analyses;
d. Assuring all sub-tier contractors have accepted the ES&H Plan;
e. Updating the ES&H Plan as required;
f. Maintaining a list of Competent Persons;
g. Assuring Hazard Analyses are understood and signed by all workers;
h. Inspecting work in progress;
i. Identifying, reporting and correcting deficiencies;
j. Assuring personal protective equipment is available;
k. Conducting tool box meetings;
l. Conducting monthly safety meetings;
m. Maintaining all safety records including minutes, training records, inspections, etc.
n. Maintaining safety related signage;
o. Assuring equipment inspections are performed;
p. Attending weekly construction meetings;
q. Coordinate permit applications with Fermilab Construction Coordinator;
r. Investigating all incidents;
s. The Subcontractor's Safety Representative or the alternate shall be present at all meetings between the Subcontractor and Fermilab at which changes in construction methodology are discussed. The Subcontractor's Safety Representative shall approve these changes.

4.2 Fermilab Project Team

4.2.1 Fermilab Construction Manager

The Fermilab Construction Manager is a Fermilab person with overall responsibility for the construction phase of the project.

4.2.2 Fermilab Construction Coordinator

The Fermilab Construction Coordinator is a Fermilab person specifically assigned to oversee the work of a project for conformance to the subcontract requirements. The Fermilab Construction Coordinator is the primary point of contact with the Subcontractor.

4.2.3 Fermilab Procurement Administrator

The Procurement Administrator is a Fermilab person specifically assigned to the project and is responsible for negotiation and administration of the subcontract terms and conditions. All modifications to the subcontract shall come from the Procurement Administrator or designee, in writing. The Procurement Administrator or designee is the sole entity that can modify the subcontract or initiate change orders.

4.2.4 Fermilab ES&H Coordinator

The Fermilab ES&H Safety Coordinator will make periodic construction site visits to provide support to the Fermilab Construction Coordinator for Laboratory oversight of the Subcontractor's safety program. Any deficiencies noted shall be brought to the attention of Fermilab Construction Coordinator for follow up with the Subcontractor. As noted in Exhibit A, Section 6.1, the ES&H Coordinator has authority to stop work activities for imminent danger, fatality, or major environmental release, but does not have authority to direct changes in the work scope of the project or the Subcontractor's means and methods of construction.

5.0 PROJECT EXECUTION

The Subcontractor shall commence work under this Subcontract on the dates set forth in the Notice To Proceed, execute the work with diligence and energy, and timely complete the work to be performed under this Subcontract (the work and work activities). In this regard, time is of the essence to the Subcontractor's performance of all activities necessary for completion of the work. Timely and successful completion of the work requires careful planning and scheduling of all work activities. The Subcontractor is responsible for the planning, scheduling, management, and

execution of the work in accordance with the Subcontract requirements.

5.1 Preconstruction Meeting

A Preconstruction Meeting is required for Subcontracts which require bonding. This meeting, chaired by the Fermilab Procurement Administrator, will typically be held after Subcontract award and before Notice to Proceed is issued. The Subcontractor's Field Superintendent is expected to attend this meeting.

5.2 Notice To Proceed

The Notice To Proceed (NTP) represents the basis of the start of the project duration. The following describes the requirements for the Notice to Proceed:

a. The NTP is issued by the Fermilab Procurement Administrator;
b. The issuance of the NTP restricts the start of work on the Fermilab Site;
c. Submittals and other work efforts not on the Fermilab site may proceed after award of subcontract and prior to NTP.
d. Submittals Required Prior to Notice to Proceed. Within ten (10) business days after subcontract award, the Subcontractor shall submit the following to Fermilab for acceptance. These items must be submitted and accepted by Fermilab prior issuance of Notice-To-Proceed (NTP).
    i. Project Hazard Analysis (if NTP is waived, a project Hazard Analysis is still required prior to commencement of work);
    ii. Project-specific Quality Control Plan (if required by Section 5.13);
    iii. Project-specific ES&H Plan (if required by Section 6)
    iv. Cost-loaded Construction Schedule (see Section 5.3 below)
    v. Soil Erosion and Sediment Control Plan (if required by Section 3.2)

5.3 Construction Schedule

The Subcontractor shall submit a practicable construction schedule as described in **Section 23 of FL-3** that will be the basis for determining job progress and payments. The format of the construction schedule shall be based on the overall project cost as described below:

a. For projects with a construction cost exceeding $3.5 million, a computer-based, cost loaded, critical path-method construction schedule is required;
b. For progress payments on projects with a construction cost of $3.5 million with a Fermilab provision (or a Subcontractor request) a cost loaded bar chart for schedule is required;
c. The construction schedule shall incorporate the Fermilab project milestones contained in **Section 5.3 of Addendum A**;
d. Project durations shall be in calendar days from the date of the NTP;
e. Dollar values shall be indicated for all work activities that result in the installation of some portion of the permanent work;
f. Off-site activities, such as procurements, shop drawings, fabrications, and mobilization shall receive a zero dollar value;
g. The dollar value of all the work activities listed in the schedule shall equal the overall subcontract price.

5.4 Weekly Progress Meetings

Weekly progress meetings will be held unless otherwise specified in **Section 5.3 of Addendum A** to coordinate the work of the Subcontractor and Fermilab. The roles and responsibilities of the participants are as follows:

a. Fermilab Construction Coordinator:
    i. Responsible for chairing the weekly progress meetings;
    ii. Responsible for meeting documentation;
    iii. Identification of the work completed since the previous progress meeting;

iv. Identification of deficiencies in the quality of construction;

b. Fermilab Design Coordinator or Fermilab Construction Coordinator:
   i. Submittal status;
   ii. Status of Request for Information;

c. Subcontractor's Field Superintendent:
   i. Prior to the weekly progress meeting, the Subcontractor shall submit a "two week look ahead" schedule that will present the status of activities that are currently in progress or expected to begin within two (2) calendar weeks from the date of the weekly progress meeting;
   ii. Subcontractor's Environment, Safety and Health observations;
   iii. Submit Quality Control documentations (if required by Section 6 of Exhibit A);
   iv. Status of deficiency list of those items of the work that do not conform to the subcontract documents;
   v. Providing a summary of the work-hours worked during the previous week;
   vi. Identification of any impact to the project cost or schedule due to the activities of Fermilab;
   vii. Identification of any work activities commenced or expected to commence that are outside the scope of the subcontract.

5.5 Monthly Construction Schedule Update Meetings

The construction schedule shall be updated monthly to accurately reflect the execution of the project. The construction schedule update shall include the following:

a. Actual start and completion dates for activities that finished during the update period;
b. Percent complete and predicted completion date for those activities that are in progress;
c. Any necessary changes to the schedule required to accurately reflect the actual sequence of work;
d. Clear identification of the critical path work activities and logic ties;
e. The Fermilab Construction Coordinator and the Subcontractor shall jointly review all construction schedule updates prior to formal submittal;
f. The date of the update will be selected by Fermilab to coincide with accepted Fermilab financial accounting periods;
g. The construction schedule shall reflect all subcontract changes that have been issued via supplemental agreement;
h. A revision summary of the changes shall be maintained on the schedule;
i. The Subcontractor shall submit a Schedule Variance (SV) report when any of the projected Fermilab specified milestones are behind schedule by more than 5% (SV=0.95 or less) of the total remaining project schedule. This report shall identify those activities that are contributing to the schedule variance;
j. When the construction schedule indicates that a Fermilab-specified milestone will be late by more than 5% of the total remaining schedule the Subcontractor shall submit a recovery schedule that will mitigate the schedule variance. This recovery shall identify those activities that are contributing to the schedule variance and the actions the Subcontractor is proposing to mitigate the variance as required by Section 23.2 of FL-3.

5.6 Permits

Fermilab conducts work through the use of on-site permits. Information concerning permits is listed below:

a. All Fermilab required permits will be identified to the Subcontractor by the Fermilab Construction Coordinator, who will arrange for all necessary permits at no cost to the Subcontractor;

b. No work activity shall be performed without the required permits;

c. Activities requiring permits include, but are not limited to:
   i. Work notification;
   ii. Excavation (see below);
   iii. Electrical work;
   iv. Burning/welding (see below);
   v. Modification to drinking water or sanitary sewer systems;
   vi. Radioactive sources on site;
   vii. Working with/on radioactive material, working in radiological areas;
   viii. Moving government or Fermilab property off site;

d. The Subcontractor will comply with all restrictions or provisions listed on permits;

e. All requests for permits shall be made a minimum of two (2) working days prior to the need for the permit;

f. Excavation Permit: An Excavation Permit issued by Fermilab via the Fermilab Construction Coordinator is required before any excavation/digging can begin at a construction site. The following requirements are associated with the Excavation Permit:
   i. Subcontractor shall coordinate the preparation of the excavation permit application with the Fermilab Construction Coordinator;
   ii. Excavation permits require a minimum of five (5) working days to process;
   iii. No excavation shall proceed without an Excavation Permit, signed by the Subcontractor Competent Person and attached to the HA. This excavation permit does not relieve the Subcontractor of his responsibility to use proper excavating techniques to find hidden and unknown utilities prior to excavating.

g. Confined Space Permit: The following sets forth the minimum acceptable requirements for confined space work at Fermilab:
   i. The Fermilab Construction Coordinator shall identify all existing confined work spaces to the Subcontractor;
   ii. If a Subcontractor is required to enter a permit-required confined space as part of their contract with Fermilab, the subcontractor shall provide the Fermilab Construction Coordinator with the following at the pre-construction meeting or at least five (5) working days prior to entry:
      a) A written copy of the Subcontractor's confined space entry program;
      b) Training records for potential entrants, attendants, and entry supervisors;
      c) Evidence that all air monitoring equipment is properly calibrated within the calibration period specified by the subcontractor's program or manufacturer's instructions. This may be in the form of a calibration log, certification

indicator on the instrument, or other means. (It is imperative that the equipment used by the Subcontractor be capable of monitoring for the contaminants associated with the confined space to be entered;

iii. It will be the Subcontractor's responsibility to provide all of their own personal protective equipment (PPE), such as lifelines, harnesses, respirators, tripods, ventilators, etc., as specified by the entry permit;

iv. In addition to complying with the permit space requirements listed above, each Subcontractor retained to perform permit-required confined space entry operations shall:

a) Obtain any available information regarding permit space hazards and entry operations from the Fermilab Construction Coordinator;

b) Coordinate entry operations with Fermilab, when both Fermilab personnel and Subcontractor personnel will be working in or near permit spaces;

c) Prior to entry, inform the Fermilab Construction Coordinator of the specific permit space procedures the Subcontractor will follow;

d) Inform the Fermilab Construction Coordinator who will inform the Fermilab Fire Department prior to entering the space;

e) Inform the Fermilab Construction Coordinator of any unanticipated hazards encountered during confined space entry;

f) Provide the Fermilab Construction Coordinator with a copy of the Subcontractor's confined space permit, reclassification form or written certification once the work has been completed.

h. Burning/Welding Permit:

Information concerning the burning/welding permit is listed below:

i. The Fermilab Construction Coordinator will contact the Fermilab Fire Department (FFD) and secure the Burn Permit;

ii. Members of the FFD will meet with the Fermilab Construction Coordinator and the Subcontractor's Field Superintendent and examine the proposed operation, prescribe precautions, assure appropriate instructions are understood, and then issue a written Burn Permit;

iii. The Subcontractor must arrange for fire watches during burning, welding, or other fire or spark generating work. This fire watch must continue for a minimum of thirty minutes after work is complete;

iv. It is the Subcontractor's responsibility to furnish the proper number and type of fire extinguishers for any welding, cutting, or brazing activities as specified in the Burn Permit;

v. The extinguishers must be located in clear sight and no farther than 50 feet from the work areas;

vi. All welding shall be in accordance with the requirements of the American Welding Society (AWS)

Standard: Safety in Welding, Cutting, and Allied Process (ANSI/ASC Z49.1-94).

vii. UL or FM listed check valves shall be installed on oxygen-fuel torch cutting equipment.

5.7 Submittals

See **Section 5.7 of Addendum A** for submittal requirements for this subcontract.

5.8 Material Substitutions

In accordance with Section 5.6 of FL-3, Fermilab Construction Subcontract Terms and Conditions, products or materials which are equal to, or the equivalent of, those specified will be considered for approval by Fermilab. The submittal procedure described in Section 5.7 of Exhibit A will be followed, with the following additional conditions:

a. In addition to the required information for the proposed substitute material, the submittal shall contain the same information pertaining to the original specified product for purposes of comparison;

b. The submittal shall explain fully the differences, if any, between the original specified product and proposed substitute product;

c. Any change to the drawings or specifications for related work required for proper installation of the proposed substitute product shall be indicated in the submittal;

d. If the proposed substitute product requires alterations of any kind to other equipment or construction, or necessitates any engineering design changes for its proper installation, such alterations and engineering design changes shall be accomplished at no cost to Fermilab;

e. The substitute submittal must contain a statement detailing the cost and schedule impact of the proposed substitution;

f. Fermilab is the sole judge of the acceptability of the proposed substitution.

5.9 Documentation

The following section describes the documentation typically required during the execution of the subcontract:

a. Weekly Progress Meeting Minutes: The Fermilab Construction Coordinator will prepare meeting minutes including a list of deficient items, corrective actions, and status of these items. These minutes will be signed by the Fermilab Construction Coordinator and the Subcontractor, and will become part of the Fermilab project file.

b. Quality Control Documentation (if required by Section 5.13 of Exhibit A);

c. Deficiency List: As segments of the work are completed, the Subcontractor's Field Superintendent shall update the list of outstanding deficient items which do not conform to the approved subcontract documents and their current status. This list will be kept current during the project and made part of the Weekly Progress Meeting Minutes.

d. Notification of Noncompliance: The Fermilab Construction Coordinator will notify the Subcontractor of deficiencies and/or discrepancies in the quality of the construction.

   i. These notifications will include:
      a) Date Identified;
      b) Identifier;
      c) Location;
      d) Description including specification or drawing reference.

   ii. The Subcontractor shall, within ten (10) working days, submit a proposed corrective action plan that details the mitigation method

including a schedule for the correction of the noncompliance

e. As-Built Documentation:
The following describes the as-built documentation required for this project:
   i. The Subcontractor shall maintain a set of prints of the Subcontract drawings in the construction office at the project site;
   ii. A daily record, in red, shall be kept on these prints of the work installed with all modifications or changes thereon. This set of prints shall be available to Fermilab for inspection at all times and print copies provided upon request to Fermilab within 24 hours of the request being made;
   iii. The Fermilab Construction Coordinator and the Subcontractor's Field Superintendent shall review the as-built drawings prior to the Monthly Construction Schedule Updates described in Section 5.5, in order to determine if the as-built mark-up set is current and accurate. The processing of the monthly payment request is contingent of the up-to-date status of the as-built documentation;
   iv. Prior to Final Acceptance described in Section 5.10, the Subcontractor shall transmit the complete set of marked-up prints to Fermilab following the submittal process described in Section 5.5;
   v. The Final Acceptance submittal shall include a statement from the Subcontractor that indicates that the work was installed as shown thereon;
   vi. Final Acceptance of the work is contingent on the receipt and approval of the complete as-built documentation.

f. Final Acceptance Documentation: Final Acceptance of the work is contingent on the receipt and approval of the following documentation:
   i. As-built documentation as described in Section 5.9.5 above;
   ii. Shop drawing record set as described in Section 5.7 (Specifications and Drawings for Construction) of FL-3, Fermilab Construction Subcontract Terms and Conditions;
   iii. Operations and Maintenance manuals.

5.10 Acceptance

Acceptance shall be made by Fermilab of all work as required by subcontract documents. In addition to the information contained in Section 9 (Inspection of Construction) of FL-3, Fermilab Construction Subcontract Terms and Conditions, the following acceptance types may be required by this project:

a. Beneficial Occupancy:
An interim inspection process used when Fermilab assumes responsibility for portions of the work listed in Section 5.3 of Exhibit A. The following details concern Beneficial Occupancy:
   i. The Subcontractor shall provide a 10-day notice to the Fermilab Construction Coordinator before this inspection is performed;
   ii. The Subcontractor’s deficiency list with status noted shall be attached to the Beneficial Occupancy documentation;
   iii. The Fermilab Construction Coordinator will complete the Beneficial Occupancy form;
   iv. For further information, reference Section 27 (Use and Possession Prior to Completion) of FL-3,

Fermilab Construction Subcontract Terms and Conditions.

b. Punch-list Inspection: An inspection of the uncompleted items of the subcontract documents. The following describes the punchlist process:
   i. When the Subcontractor believes the work is substantially complete, the subcontractor shall update the deficiency list for presentation to the Fermilab Construction Coordinator;
   ii. The Subcontractor shall provide a 10-day notice to the Fermilab Construction Coordinator before this inspection is performed;
   iii. The Fermilab Construction Coordinator will arrange for an inspection visit of Fermilab stakeholders to verify the accuracy of the Subcontractor's deficiency list and to add, as necessary, those items of work that are not complete;
   iv. The Fermilab Design Coordinator will develop a comprehensive punchlist and issue it to the Subcontractor;
   v. The Subcontractor and the Fermilab Construction Coordinator will sign off on the completion of each punchlist item.
c. Final Acceptance: This inspection will document the completion of the project scope. The following describes this process:
   i. The Subcontractor shall provide a five (5) day notice prior to the Final Acceptance inspection;
   ii. The Subcontractor shall submit documentation that the work associated with the punchlist is complete;
   iii. The Fermilab Construction Coordinator will coordinate the final inspection walkthrough with Fermilab stakeholders;
   iv. The Fermilab Construction Coordinator will develop and issue the final acceptance documentation.

5.11 Project Bulletin Board

Section 5.11 of Addendum A contains information regarding the requirements for a project bulletin board.

5.12 Jobsite Safeguards

The Subcontractor shall be responsible for providing and implementing the necessary precautions to safeguard material and equipment at the project site.

In the event of theft or damage to Subcontractor property, Fermilab property, and/or Government property, the Subcontractor shall immediately notify Security Dispatch by telephone (630) 840-3414.

5.13 Quality Requirements

The Subcontractor is responsible for all activities necessary to manage, control, and document that work complies with the Subcontract documents. The Subcontractor's responsibility includes ensuring adequate Quality Control services are provided for work accomplished on- and off-site by his/her organization, suppliers, sub-tier contractors, technical laboratories, and consultants. The work activities include safety, submittal management, testing and inspection, and all other functions relating to the requirement for quality construction. See **Section 5.13 of Exhibit A** for the project specific requirements for the work under this subcontract.

6.0 ENVIRONMENT SAFETY AND HEALTH

This section describes the requirements, responsibilities and expectations for the environment, safety and health aspects of this project.

6.1 Stop Work Authority

Any Fermilab employee may stop a work activity if there is imminent danger of serious injury, fatality, or major environmental release. If the hazard cannot be abated in a timely manner, the work activity shall be stopped through the use of a Stop Work Order. Work shall not be permitted to continue until the hazardous situation has been eliminated and Fermilab has issued a Restart Work Order.

6.2 Environment Safety and Health Program

The Subcontractor shall have an effective Environment, Safety and Health (ES&H) program incorporating the philosophy of Integrated Safety Management (ISM), defined as a system for performing work safely and in an environmentally responsible manner. The term "integrated" is used to indicate that the Environment, Safety & Health (ES&H) management systems are normal and natural elements of accomplishing work. The intent is to integrate the management of ES&H with the management of the other primary elements of construction: quality, cost, and schedule. Fermilab subscribes to the philosophy of Integrated Safety Management (ISM) by following the program outlined in this section. Fermilab also requires this of subcontractors and sub-tier subcontractors.

6.3 Environment Safety and Health Plan

The Subcontractor shall have an ES&H Plan that is commensurate with the complexity and nature of the work activities. This ES&H Plan will describe the Subcontractor's overall commitment to safety and measures that will be taken specific to this project work scope and site. The following describes the ES&H Plan requirements:

a. Per FL-14, all subcontracts that require performance bonding will require the Subcontractor shall submit to Fermilab one (1) printed copy and one (1) electronic copy in Adobe portable document format (PDF);

b. The ES&H Plan is to address the Subcontractor's commitment to each of the following principals. A brief explanation and key elements to be addressed follows each:

i. Line Management Responsibility for Safety: Line management shall be responsible and accountable for the protection of the employees, the public, and the environment. Examples of expected items to support this statement are:
   a) Statement of ES&H policy and goals;
   b) Workforce is held accountable for strict compliance with subcontractor's ES&H plan;
   c) Process for progressive discipline;
   d) Means of holding sub-tier contractors accountable for compliance with ES&H requirements;
   e) Evidence of worker participation;
   f) Participation of management in safety meetings, inspection, and documentation;
   g) Process for employees to identify and help resolve ES&H issues quickly, including stop work authority; and
   h) Management support without hint of retribution or harassment.

ii. Clear Roles and Responsibilities: The roles and responsibilities, and authority at all levels of the organization, including potential sub-tier subcontractors are clearly identified. Examples of expected items to support this statement are:
   a) ES&H and Quality Control responsibilities for principals, field superintendent, foremen,

competent person, ES&H officer, and workforce are documented; and

b) Stop work authority.

iii. Competence Commensurate with Responsibility: Personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities. Examples of expected items to support this statement are:

a) Identification of required training & experience of field superintendent, foremen, competent person, ES&H personnel, and workforce;

b) Identification of process for documenting completion of training;

c) Process for assuring sub-tier contractors are adequately skilled to perform their work activities; and

d) Training for employees and sub-tiers employees on Integrated Safety Management and hazard analysis.

iv. Balanced Priorities: Resources are effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed. Examples of expected items to support this statement are:

a) Management commitment of resources to adequately implement their ES&H program;

b) Selection process for sub-tier contractors that include cost, quality, schedule adherence, and safety performance; and

c) Process for subcontractor to authorize start of work by sub-tier contractors.

v. Identification of Safety Standards and Requirements: Before work commences, the associated hazards are evaluated and an agreed upon set of safety standards and requirements are established which will provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences. Examples of expected items to support this statement are:

a) Subcontractor ES&H Program Plan, by reference;

b) Subcontractor QC Program Plan, by reference; and

c) Hazard analysis process which includes defining scope of work, analysis of hazards, identification of hazard controls, requirement to perform work within these controls, and means to provide feedback and improvement.

vi. Hazard Controls Tailored to Work Being Performed: Administrative and engineering controls, tailored to the work being performed, are present to prevent and mitigate hazards. Examples of expected items to support this statement are:

a) Hazard analysis process;

b) Subcontractor ES&H Program Plan, by reference;

c) Planning and selection of appropriate and effective protective measures;

d) Active regimen of workplace inspections and prompt abatement of identified hazards; and

e) Inspections, assessment, and audits of sub-tier contractor's adherence to ES&H and QC program.

f) Daily work planning and hazard reviews at the worker level.

vii. Operations Authorization: The conditions and requirements to be satisfied for operations to be initiated and conducted are clearly established and understood by all. Examples of expected items to support this statement are:

a) Process to assure workers are informed of hazards and required

protective measures before work is allowed to begin;

b) Process to assure workers, including sub-tier contractors are appropriately trained to do their job safely;

c) Process to assure that when an incident occurs, the scene is secured until the incident investigation is complete.

d) Investigation process includes analysis, examination of trends and lessons learned, and a means to report to Fermilab in a timely manner.

e) Process to assure that applicable Fermilab permits are in place prior to allowing work to commence.

c. The ES&H Plan shall include site-specific information of the Subcontractor's activities at Fermilab and shall encompass all applicable aspects of 29 CFR 1910, "OSHA Safety and Health Standards for General Industry"' and 29 CFR 1926, "Safety and Health Regulations for Construction".

d. The ES&H Plan should describe the following:

i. Basic Safety And Health Provisions including Emergency Action/Response Plan, Accident Investigation Program, Recording and Reporting of Injuries, Housekeeping, Hazard Communication Plan, Personal Protective Equipment and Fire Protection and Prevention.

ii. Hazard Analysis Process: including how hazards are identified and analyzed, preventive controls and the periodic inspection program;

iii. Waste Handling And Disposal including characterization of waste, packaging and labeling requirements and assurance that appropriate transportation and handling facilities will be used;

iv. Erosion Control And Environmental Protection including Storm Water Pollution Prevention Plan (SWPPP) when required and Erosion/Sediment Control Plan(s).

v. Other Programs (as dictated by the scope of this work) including the following:

a) Control of Hazardous Energy (Lockout/Tagout);
b) Confined Space Entry;
c) Hearing Conservation;
d) Ionizing Radiation;
e) Nonionizing Radiation;
f) Lead, Beryllium, or Other Metals;
g) Electrical (including Power Transmission and Distribution);
h) Welding and Cutting;
i) Scaffolds;
j) Fall Protection;
k) Excavations;
l) Signs, Signals, And, Barricades;
m) Tools - Hand and Power;
n) Ladders & Stairways;
o) Commercial Diving Operations;
p) Motor Vehicles, Mechanized Equipment, and Marine Operations;
q) Cranes, Derricks, Hoists, Elevators, and Conveyors;
r) Concrete and Masonry Construction;
s) Steel Erection;
t) Underground Construction, Caissons, Cofferdams, & Compressed Air;
u) Demolition;
v) Blasting and the Use of Explosives

e. Changes and Updates: The ES&H Plan is a living program and updates that reflect changes to processes and plans shall be

submitted as changes are made. Changes may be required for acceptance of plan by Fermilab prior to Notice To Proceed. Once accepted by Fermilab, the Subcontractor shall be required to comply with the requirements set forth in their plan. Once accepted, all revisions shall be submitted to PM for review and acceptance.

f. All sub-tier subcontractors employed by the Subcontractor must either agree in writing to follow the Subcontractor's ES&H Program Plan or submit to the Subcontractor for acceptance one (1) printed copy and one (1) electronic version in Adobe portable document format (pdf) of the Sub-tier subcontractor's ES&H Plan.

6.4 Job Site Orientation

The Subcontractor shall ensure and demonstrate; through a documented job site orientation program that sub-tier subcontractor personnel are aware of the ES&H requirements of the job. The Sub-tier subcontractors working for the Subcontractor shall follow and perform all required ES&H programs defined by the Subcontractor's approved and accepted ES&H program for the job site. Depending on the complexity of the project the hazard analysis (see Section 6.5 below) may serve as the job site orientation.

6.5 Hazard Analysis

The hazard analysis details the specific hazards associated with the work activities and mitigating actions (including personal protective equipment) that the Subcontractor and Sub-tier subcontractors will take to reduce or eliminate the risk of injury. The following information concerns the analysis:

a. A Fermilab accepted hazard analysis shall be required for all work activities;
b. The initial hazard analysis shall be submitted and accepted by Fermilab prior to notice to proceed (NTP). This initial HA shall include hazard analysis for work tasks planned for the beginning phases of the project;
c. All subcontractor and sub tier subcontractor employees are required to sign the analyses affecting their work thereby acknowledging understanding of the hazards and the mitigation activities. The signature list shall be available for review by the Fermilab Construction Coordinator. As the analysis is updated, the subcontractor and sub-tier subcontractor employees shall be advised of the new information and re-sign the document;
d. Prior to the start of subsequent new work activities, the Subcontractor shall review and revise the hazard analysis, or develop a new hazard analysis, as necessary to incorporate new hazards. Each revision must be submitted and accepted by Fermilab before the associated element of work is begun;
e. Material Safety Data Sheets (MSDS) or Safety Data Sheet (SDS) of products that may significantly impact the safety of Fermilab or subcontractor personnel are to be submitted as part of the hazard analysis process;
f. The name of Competent Persons shall be included on the hazard analysis and communicated to all affected workforces;
g. Specific procedures in the areas of fall protection, excavation, confined space, hoisting and rigging, and Lockout/Tagout may be required as job conditions dictate;
h. The Fermilab Construction Coordinator will provide informal hazard analysis training for Subcontractor and sub-tier contractor personnel upon request.

6.6 Reporting Requirements

The following requirements concern Subcontractor reporting requirements:

a. All emergencies occurring at the Fermilab site must be reported immediately by dialing extension 3131 from a Fermilab phone or 630-840-3131. The types of emergencies to be reported include: injury or illness requiring emergency care, fire, explosion, security incident, vehicle accident, radiation incident, utility failure, tornado sighting, and hazardous material spill or release;
b. All incidents, including any injury/illness, any non-emergency incident and near misses must be reported immediately to the Fermilab Construction Coordinator. All incident scenes involving injuries shall be preserved and secured by the Subcontractor to enable Fermilab and DOE to conduct any necessary investigations. After any necessary emergency response is made, the scene shall be left unchanged and protected until the Fermilab Construction Coordinator is notified and releases the incident site for work to continue;
c. The Subcontractor must investigate all incidents (including near misses). The Subcontractor shall submit, within 48 hours of an incident, a written report of an investigation. The investigation must include root causes, corrective actions and preventive measures.

6.7 Subcontractor Training

The following requirements concern Subcontractor training:

a. All Subcontractors working at Fermilab shall attend Subcontractor Orientation which is a half-hour presentation conducted weekdays at 7:30 a.m. All Subcontractor employees will receive a card documenting attendance. This training must be repeated every two years;
b. The Subcontractor shall be responsible for assuring that their employees and sub-tier Subcontractor employees, who do not speak English, understand all ES&H requirements. The Subcontractor must be able to communicate any necessary instructions to those employees;
c. Subcontractors shall maintain and provide to Fermilab upon request any and all records related to ES&H training that was provided by the Subcontractor or others and received by Subcontractor employees performing subcontractor activities at Fermilab. Records of safety meetings, which include training, shall also be maintained by the Subcontractor and provided to Fermilab upon request.
d. All Subcontractors performing work at Fermilab shall provide to their employees any necessary ES&H training as may be required by Federal/State regulations and as appropriate for their Subcontract activities at Fermilab. Exceptions involve hazards, which are unusual for the trade of the Subcontractor's employees. In particular, Fermilab normally provides appropriate training for Subcontractors working in radiation areas or oxygen deficient hazard areas, and expected emergency response.

6.8 Subcontractor Safety and Health Records

The following requirements concern Subcontractor training:

a. Subcontractors shall maintain and provide to Fermilab upon request, any and all occupational safety and environmental records. Such records include, but are not limited to, the records required to be maintained by federal/state regulation. Such records include OSHA injury/illness logs, training records, inspection records, safety meetings, and incident investigations. Additional records appropriate for the Subcontractor's activities shall also be

maintained and provided to Fermilab upon request (e.g., crane inspections, welding certifications, etc.).

b. If the Subcontractor intends to administer first aid or Cardio Pulmonary Resuscitation (CPR), the Subcontractor must comply with 29 CFR 1926 and have available the list of names of any employee who will administer first aid or CPR, along with current certifications.

6.9 ES&H Inspections

After the start of construction and throughout the entire construction period, the Subcontractor shall monitor and inspect the construction area and operations for compliance with the Subcontractor's accepted ES&H plan. The Subcontractor's Field Superintendent is expected to conduct these inspections and correct any deficiencies found. These inspections shall be documented by the Subcontractor. Records shall be available for review upon request.

6.10 Job Site ES&H Meetings

The following requirements concern Job Site ES&H meetings:

a. Daily Work Planning Meetings in the form of daily briefings shall be conducted by the Subcontractor with his employees to discuss the planned work activities, review the applicable hazard analysis, and allow for employee questions and feedback regarding the work activity;

b. Weekly Toolbox Meetings of approximately five (5) minutes duration shall be conducted at the job site by the various area/job foreman or superintendents for their specific crafts. These meetings shall emphasize the current construction operations and provide an opportunity for inspection of tools and personal protective equipment;

c. Monthly ES&H Meetings may be required for this project. See **Section 6.10 of Addendum A**;

d. The Subcontractor will document meetings (date, topic, attendance, etc.) and provide a copy to Fermilab;

e. The Fermilab Construction Coordinator will be notified of all job site ES&H meetings and may attend.

6.11 Personal Protective Equipment

The Subcontractor shall furnish personal protective equipment (PPE) as required to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective in reducing these exposures to acceptable levels. Listed below are the minimum acceptable PPE for work on the Fermilab site:

a. Hard hats shall be furnished by the Subcontractor and shall be worn in the construction work areas as designated in the Hazard Analysis and/or applicable OSHA standards. Hard hats shall meet the ANSI Z89.1 standard as required by 29 CFR 1926.100 and bear the "Z89.1" designation. High voltage exposure work requires hard hats that meet the ANSI Z89.2 standard and bear the "Z89.2a" designation;

b. Safety glasses with side shields shall be furnished by the Subcontractor and shall be worn in the construction work areas as designated in the Hazard Analysis and/or applicable OSHA standards. Safety glasses shall meet the ANSI Z87.1 standards;

c. Clothing suitable for the work and weather conditions is required. In construction areas, the minimum shall be short (1/4 length) sleeve shirt, long trousers, and hard sole leatherwork boots providing ankle protection. In addition, any work that presents a greater hazard to the feet or toes requires the use of safety toed or metatarsal guards, meeting ANSI Z41. Canvas, tennis, or deck shoes

are not permitted within the construction work area.

6.12 Electrical Work

The following sets forth the minimum acceptable requirements for work on electrical systems at Fermilab:

a. All electrical work shall be performed in accordance with NFPA 70E, Standard for Electrical Safety in the Workplace;
b. The Subcontractor personnel must be trained in Lockout/Tagout (LOTO) prior to participating in LOTO of hazardous energy sources and working on LOTO systems or equipment;
c. The Subcontractor shall provide ground fault circuit interrupter protection for electric hand held tools, portable generators, temporary electrical extension cords and other wiring, etc. The assured equipment-grounding program is not an acceptable alternative at Fermilab.

6.13 Oxygen Deficient Hazards

The following sets forth the minimum acceptable requirements for oxygen deficient hazard (ODH) work at Fermilab:

a. Fermilab has policies and procedures governing work in ODH areas. The Fermilab Construction Coordinator will communicate specific requirements and work practices to the Subcontractor;
b. All Subcontractor and Sub-tier contractor personnel who must enter designated ODH areas must have and display a level of medical fitness acceptable to Fermilab prior to entering those areas;
c. Fermilab will assess the need for ODH training for Subcontractor personnel. If ODH training is necessary Fermilab will provide it free of charge.
d. Oxygen monitoring equipment will be supplied to the Subcontractor personnel, as necessary. The Subcontractor is responsible for returning this equipment upon request or upon completion of the work;
e. Fermilab will furnish emergency evacuation equipment. Care, use, and the return of such equipment will be the responsibility of the Subcontractor.

6.14 Radiation Protection

The following sets forth the minimum acceptable requirements for radiation protection at Fermilab:

a. Fermilab has policies and procedures governing radiological work. The Fermilab Construction Coordinator will advise the Subcontractor of the requirements and work practices, if potential for radiation affects the work scope;
b. Fermilab will assess the need for radiological training for Subcontractor personnel. If radiological training is necessary it will be provided free of charge by Fermilab;
c. Radiation dosimeters will be supplied to the Subcontractor personnel, as necessary. The Subcontractor is responsible for returning this equipment upon request or upon completion of the work;
d. Fermilab will furnish protective clothing. Disposal of such clothing will be the responsibility of Fermilab;
e. Prescribed procedures for material handling and segregation shall be followed explicitly. Potentially radioactive material must be surveyed prior to removal from site. The Fermilab Construction Coordinator shall coordinate this survey.

6.15 Environmental Protection

All construction work on the Fermilab site shall comply with all applicable environmental executive orders, laws, regulations, and

permits. All Subcontractors and sub-subcontractors shall conduct their activities in an environmentally sound manner that limits the risks to the environment and protects the public health. The following sets forth the minimum acceptable requirements for environmental protection at Fermilab:

a. See **Section 3.2 of Addendum A** for the Soil Erosion and Sedimentation Control (SESC) requirements for this project;
b. If required, the Subcontractor shall install all erosion control in accordance with SESC plan prior to the start of excavation activities;
c. Excavation at or adjacent to streams' tributaries, or other drainage outfalls shall be done only after notification to the Fermilab Construction Coordinator;
d. The Fermilab Construction Coordinator will inform the Subcontractor if any wetlands are present in work area and what protective measures are necessary;
e. Unexpected environmental impacts shall be immediately reported to the Fermilab Construction Coordinator and mitigated by the Subcontractor;
f. Flammable and/or combustible liquids, fuels, and oils shall be provided with containment and shall not be stockpiled beyond one day's usage. Storage of these materials, plus maintenance and fueling areas used by the Subcontractor, shall be properly graded and maintained and shall be located a minimum of 100 feet away from a wetland or water body boundary so that adverse effects on the environment are eliminated;
g. The Subcontractor shall make routine inspections to assure that all motorized equipment is free of leaks of petroleum and other toxic or hazardous materials. The Subcontractor shall keep sufficient cleanup supplies on hand (e.g. oil dry, absorbent booms, etc.) to contain/absorb any spill or leak of fuels, oils, etc. that could potentially leak from his equipment. If a spill or leak should occur, the Subcontractor should immediately take appropriate steps to contain spills, move equipment out of sensitive areas (near wetland or water body) and immediately notify the PM;
h. At the close of each workday, the Subcontractor's Field Superintendent shall inspect the complete construction site to insure that all erosion controls, drainage patterns, excavations and staging areas are in environmentally sound condition for the weather conditions anticipated.

6.16 Open Burning, Fire Barrels, Coal or Kerosene Type Salamanders

Open burning, fire barrels, coal or kerosene type salamanders, or open flame heating devices that have exposed fuel below the flame are not allowed on the Fermilab site. The following sets forth the minimum acceptable requirements for temporary heating devices at Fermilab:

a. Spark arresters shall be provided on all stacks or burning devices having forced drafts;
b. Temporary heating devices, used in any enclosed building, room, or structure, shall be listed by UL, FM, ETL, or other approval-testing laboratory and vented to the outside.
c. Flammable liquid fixed heaters shall be listed by UL, FM, ETL, or other approval-testing laboratory and equipped with a primary safety control to stop flow of fuel in the event of a flame failure. Barometric or gravity oil feeds are not acceptable primary safety controls.

6.17 Smoking

Smoking is prohibited in locations where flammable and/or combustible materials are stored. "No smoking" signs shall be posted in

these areas. Smoking is prohibited in all Fermilab buildings except in designated areas.

6.18 Fuel Storage Tanks

The following sets forth the minimum acceptable requirements for vehicles and equipment at Fermilab:

a. Above ground fuel storage tanks for construction vehicles shall not be permitted on the Fermilab site;
b. Fuel tanks mounted on pick-up trucks shall conform to the requirements of the Illinois State Fire Marshall's Office;
c. Fuel tanks mounted on pick-up trucks shall be removed from the Fermilab site at the end of each workday;
d. Refueling of equipment while the motor is running is prohibited;
e. During refueling from truck-mounted fuel tanks or with portable fuel cans, etc., a 20-pound (minimum) A-B-C dry chemical fire extinguisher must be present;
f. Maintenance and fueling areas used by the Subcontractor shall be properly graded and maintained and shall be located a minimum of 100 feet away from a wetland or water body boundary to avoid adverse effect on the environment.

6.19 Explosives

The use of explosives is not permitted without prior written approval of the Fermilab Director or his designee

6.20 Vehicles and Equipment

The following sets forth the minimum acceptable requirements for vehicles and equipment at Fermilab:

a. Operators must have an appropriate, valid driver's license when operating vehicles on site. Seat belts are required to be provided and worn for the operators and passengers of all vehicles;
b. All vehicles and mobile powered equipment, except automobiles and pickup trucks, shall have reverse signal alarms (a.k.a. backup alarms) audible above the surrounding noise level. If backup alarms are not present on the equipment, a spotter (other than the driver of the vehicle) must be present to warn pedestrians and the drivers of other moving equipment;
c. If required by the equipment manufacturer, roll over protection structures shall be provided;
d. Personnel lifts must be equipped with audible motion alarms. These alarms must be in operation and audible over the surrounding ambient noise when the lift is in use. Additionally, all lifts require two distinct actions in order to make the lift move in a forward or backward direction or in an upward or downwards direction. A foot pedal is considered one of the actions if independent of the other controls;
e. The equipment manufacturer must approve any modifications to lifting and hoisting equipment;
f. All hand and power tools must be checked prior to use on each shift to assure that they are maintained in a safe condition. Any deficiencies shall be repaired, or defective parts replaced, before continued use.
g. Equipment inspection and modification (The subcontractor shall comply with 29 CFR 1926.600, Subpart O):
    i. The Subcontractor must inspect all heavy equipment before use on site, prior to use on each shift, and during use to make sure it is in safe operating condition. Defective equipment shall be removed from service;
    ii. The Subcontractor is to assure that regulatory inspection records are complete and up-to-date and that operating manuals are available;
    iii. In no case shall the original safety factor of the equipment be reduced.

h. All tools and equipment brought on site by the Subcontractor are subject to inspection by Fermilab. Items found to be out of compliance shall be repaired or immediately removed from service, tagged out of service.

6.21 Emergency Egress and Severe Weather

The following sets forth the minimum acceptable requirements for emergency egress and severe weather protection at Fermilab:

a. All emergency egress routes shall be kept clear at all times;
b. Severe weather shelter locations and specific evacuation procedures will be provided by the Fermilab Construction Coordinator;
c. The Subcontractor shall communicate egress routes and severe weather shelter to his employees and all sub-subcontractors.

6.22 Work Completion and Clean Up

All work and clean-up operations shall be in compliance with the Subcontractor's ES&H Plan. Requested documentation for all aspects of the ES&H program shall be complete and submitted prior to Subcontract close-out.

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SECTION 01524 - CONSTRUCTION WASTE MANAGEMENT AND RECYCLING

PART 1. GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Construction waste management plan.

2. Construction waste recycling.

1.03 PLAN REQUIREMENTS

A. Develop, submit, and implement a Construction Waste Management plan to recycle or salvage at least 50 percent of the non-hazardous construction, demolition and land clearing materials, excluding soil, for compliance with DOE Guiding Principle.

1.04 SUBMITTALS

A. Construction Plan: Submit construction waste management plan describing methods and procedures for implementation and monitoring compliance including the following:

1. Transportation company hauling construction waste to waste processing facilities.

2. Recycling and adaptive reuse processing facilities and waste type each facility will accept.

3. Construction waste materials anticipated for recycling and adaptive reuse.

4. On site sorting and site storage methods.

B. Submit documentation prior to Substantial Completion, substantiating construction waste management plan was maintained and goals were achieved.

1. Trash: Quantity by weight deposited in landfills. Include associated fees, transportation costs, container rentals, and taxes for total cost of disposal.

2. Salvaged Material: Quantity by weight with destination for each type of material salvaged for resale, recycling, or adaptive reuse. Include associated fees, transportation costs, container rentals, and taxes for total cost of disposal. Also include reimbursements due to salvage resale.

3. Total Cost: Indicate total cost or savings for implementation of construction waste management plan.

1.05 CONSTRUCTION WASTE MANAGEMENT PLAN

A. Construction Waste Landfill Diversion: Minimum 50 percent by weight of construction waste materials for duration of Project through resale, recycling, or adaptive reuse.

B. Implement construction waste management plan at start of construction.

C. Review construction waste management plan at pre-construction meeting and progress meetings

D. Distribute approved construction waste management plan to subcontractors and others affected by Plan Requirements.

E. Oversee plan implementation, instruct construction personnel for plan compliance, and document plan results.

1.06 CONSTRUCTION WASTE RECYCLING

A. The Contractor shall have the option of sorting the materials off-site or on-site.

1. Off-Site: If the Contractor chooses to sort the material off-site, he shall provide the provide the name of the vendor, and provide procedures on the documentation of the recyclable waste.

2. On-Site: The contractor shall provide separate collection containers for a minimum of the following materials:

a) Untreated lumber.

b) Gypsum wallboard.

c) Paper, paper products, and cardboard.

d) Plastics.

e) Metals.

f) Glass.

g) Other salvageable materials.

1.07 CONSTRUCTION WASTE ADAPTIVE RE-USE

A. Arrange with processing facility for salvage of construction material and processing for reuse. Do not reuse construction materials on site except as accepted by Owner.

1.08 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable local ordinances and regulations

B. Disposal Sites, Recyclers, and Waste Materials Processors: Use only facilities properly permitted by the State of Illinois, and by local authorities where applicable.

C. Prior to beginning work at the site, schedule and conduct a conference to review the Construction Waste Management Plan and discuss procedures, schedules and specific requirements for waste materials recycling and disposal. Discuss coordination and interface between the Subcontractor and other construction activities. Identify and resolve problems with compliance with requirements. Record minutes of the meeting, identifying all conclusions reached and matters requiring further resolution.

1. Attendees: The Subcontractor and related Subcontractor personnel associated with the work of this section, including personnel to be in charge of the waste management program; the Construction Quality Manager; CC; and such additional personnel as Fermilab deems appropriate.

2. Plan Revision: Make any revisions to the Construction Waste Management Plan agreed upon during the meeting and incorporate resolutions agreed to be made subsequent to the meeting. Submit the revised plan to Fermilab for approval.

D. Implementation: Designate an on-site person responsible for instructing workers and implementing the Construction Waste Management Plan. Distribute copies of the Construction Waste Management Plan to the job site foreman and each subcontractor. Post Waste Management Plan on the job site bulletin board. Include waste management and recycling in worker orientation and review periodically. Provide on-site instruction on appropriate separation, handling, recycling, and salvaging methods to be used by all parties at the appropriate stages of the work at the site. Include waste management and recycling discussion in pre-fabrication meetings with subcontractors and fabricators. Also include discussion of waste management and recycling in regular job meetings and job safety meetings conducted during the course of work at the site.

PART 2. PRODUCTS - Not Used

PART 3. EXECUTION

3.01 CONSTRUCTION WASTE COLLECTION

A. Collect construction waste materials in marked bins or containers and arrange for transportation to recycling centers or adaptive salvage and reuse processing facilities. Remove all indicated recyclable materials from the work location to approved containers daily. Failure to remove waste materials will be considered cause for withholding payment and termination of Contract

B. Change out loaded containers for empty ones as demand requires, but not less than weekly.

C. Handling: Deposit all indicated recyclable materials in the containers in a clean (no mud, adhesives, solvents, petroleum contamination), debris-free condition. Do not deposit contaminated materials into the containers until such time as such materials have been cleaned.

D. If the contamination chemically combines with the material so that it cannot be cleaned, do not deposit into the recycle containers. In such case, request resolution by the Construction Quality Manager as to disposal of the contaminated material. Directions from the Construction Quality Manager do not relieve the Subcontractor from compliance with all legal and regulatory requirements for disposal, nor shall such directions cause a request for modification of the Contract

E. Maintain recycling and adaptive reuse storage and collection area in orderly arrangement with materials separated to eliminate co-mingling of materials required to be delivered separately to waste processing facility.

F. Store construction waste materials to prevent environmental pollution, fire hazards, hazards to persons and property, and contamination of stored materials.

G. Cover construction waste materials subject to disintegration, evaporation, settling, or runoff to prevent polluting air, water, and soil.

3.02 CONSTRUCTION WASTE DISPOSAL

A. Deliver construction waste to waste processing facilities. Obtain receipt for deliveries.

B. Dispose construction waste not capable of being recycled or adaptively reused by delivery to landfill, incinerator, or other legal disposal facility. Obtain receipt for deliveries.

END OF SECTION 017419

SECTION 01572 - INDOOR AIR QUALITY DURING CONSTRUCTION

PART 1. GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Construction indoor air quality (IAQ) management plan.

2. HVAC air filters.

3. Building flush-out.

1.03 PLAN REQUIREMENTS

A. Develop, submit and implement construction IAQ management plan in accordance with SMACNA IAQ “Guidelines For Occupied Building Under Construction”, for compliance with the DOE Guiding Principle requirement. The plan shall include building flushout after construction and prior to occupancy.

1.04 SUBMITTALS

A. Product Data: Submit description and performance data for filters, including MERV ratings.

B. Construction Plan: Submit construction IAQ management plan describing methods and procedures for implementation and monitoring compliance.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents: Submit construction photographs showing compliance with construction IAQ management plan.

B. Flushout documentation: Submit signed letter documenting that the building flushout is successfully accomplished in accordance with the approved IAQ management plan.

1.06 CONSTRUCTION IAQ MANAGEMENT PLAN

A. HVAC PROTECTION

1. Seal off all supply louvers, return air grilles, and air intake/discharge points to prevent construction dust and debris from entering.

2. Seal off all ductwork openings and air outlets with plastic sheeting to protect the duct system from dust and debris. Do not re-open until the end of activities that produce dust or pollution, such as drywall sanding, concrete cutting, masonry work, wood sawing, and so forth.

3. If for some unforeseen reason, there should arise a circumstance wherein the return air system is required to be used during the construction phase, install temporary filters (as determined by ASHRAE Standard 52.2-1999 and of type as used in the final installation) at each return air opening and supply air intakes, and provide frequent inspection and maintenance. If inspections by CC or Commissioning Agent reveal that the ductwork has become contaminated due to inadequate protection, the ductwork shall be cleaned professionally prior to the first phase of occupancy, using procedures established in ACR 2005 published by the National Air Duct Cleaners Association. Replace these filters prior to building flushout.

4. Under no circumstances shall air be returned from a construction area and then recirculated through the permanent supply ductwork, unless and until the level of construction in the relevant area involves final finishes and trim and the construction has reached a point of complete building dry-in with no sanding and is free from dust, debris, and contaminants.

5. Do not use fan rooms to store construction or waste materials, and keep them clean and neat.

B. SOURCE CONTROL

1. Limit construction traffic and motor idling in the vicinity of air intake louvers when the HVAC systems are activated. Restrict motor vehicles to areas well-removed from air intakes, preventing emissions from being drawn into the building.

2. Use electric or natural gas alternatives for gasoline and diesel equipment where possible and practical.

3. Cycle equipment off when not being used or needed.

4. Avoid the use of materials and products with high VOC and/or particulate levels. Use products and installation methods with low VOCs such as paints, sealers, insulation, adhesives, caulking and cleaners. Comply with the requirements in other Specification Sections.

5. Keep containers of wet products closed as much as possible. Cover and seal waste materials which can release odor or dust.

6. Protect all materials, especially absorbent materials such as insulated ductwork, against moisture during delivery to and storage at the job site. Store materials inside the structure in a dry and clean environment pending installation

C. PATHWAY INTERRUPTION

1. Use dust curtains or temporary enclosures to prevent dust from migrating to other areas when applicable. During construction, isolate areas of work to prevent contamination of clean or occupied areas.

2. Keep pollutant sources as far away as possible from ductwork and areas occupied by workers when feasible.

3. Isolate work areas and/or create pressure differentials to prevent the migration of contaminants.

4. Use portable fan systems to exhaust contaminated air directly to the outside of the building, and discharge the air in a means to prevent it from re-entering

D. HOUSEKEEPING

1. General housekeeping, and dust suppression programs shall include the use of wetting agents or sweeping compounds. Use efficient and effective dust collecting methods such as damp cloths, wet mops, and vacuums with particulate filters, or wet scrubbers. Institute cleaning activities of building areas on a daily basis, and of HVAC equipment as required.

2. Keep all coils, air filters, dampers, fans, and ductwork clean during installation, and clean them as required prior to performing the testing, adjusting and balancing of the systems.

3. Avoid accumulations of water inside the building, and promptly remove any that may occur. Especially protect porous materials such as insulation and ceiling tiles from exposure to moisture

4. Provide photographs of the above activities during construction to document compliance

E. SCHEDULING

1. Sequence construction activities carefully over the duration of the project to minimize the impact on IAQ. Plan adequate time to conduct flushout before occupancy.

2. Install new filters, of types required and specified for the final installation, at the central fan system, immediately prior to occupancy for each respective.

PART 2. PRODUCTS

2.01 HVAC AIR FILTERS

A. Return Filters: Filtration media rated for minimum efficiency reporting value (MERV) when tested in accordance with ASHRAE 52.2.

1. Construction Return Filters: MERV of 8, minimum.

2. Flush-Out Return Filters: MERV of 13, minimum.

3. Permanent Filters: As specified in Mechanical Section or Equipment Schedule

PART 3. EXECUTION

3.01 IAQ PLAN

A. Implement Construction IAQ Management Plan at start of construction.

B. Review Construction IAQ management plan at pre-construction meeting and progress meetings

C. Distribute approved Construction IAQ Management Plan to subcontractors and others affected by Plan Requirements.

D. Oversee plan implementation, instruct construction personnel for plan compliance, and document plan results.

3.02 FILTER INSTALLATION AND REPLACEMENT

A. Install construction return filter at each return grille before operating permanent air handlers during construction.

B. Replace filters after completing construction and before conducting building flush-out.

1. Replace construction return filters with flush-out return filters.

2. Replace supply filters.

C. Replace filters after conducting building flush-out and before occupancy.

1. Replace flush-out return filters with permanent filters.

2. Replace supply filters.

3.03 BUILDING FLUSH-OUT

A. Conduct building flush-out after construction ends and before occupancy for minimum 72 hours with maximum outdoor air consistent with achieving indoor relative humidity no greater than 60 percent.

3.04 CONSTRUCTION PHOTOGRAPHS

A. Photograph construction operations to show compliance with SMACNA IAQ and construction IAQ management plan.

1. Take minimum six photographs on minimum three different occasions during construction to show consistent adherence with specified requirements.

END OF SECTION 01572

SECTION 01810 – GENERAL REQUIREMENTS – DOE GUIDING PRINCIPLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements and procedures for compliance with U.S. Department of Energy's Guiding Principles for New Construction. The goal of these Guiding Principles for Sustainable Buildings is to design buildings to be energy efficient, conserver resources, and provide comfortable and healthy environments for occupants.

B. Guiding Principles Items incorporated into the Design:

1. Commissioning
2. Energy Efficiency
3. Measurement and Verification
4. Indoor Water – Water Savings
5. Indoor Water – Measurement and Verification
6. Water Efficient Products
7. Ventilation and Thermal Control
8. Moisture Control
9. Day-lighting
10. Day-lighting – Lighting Controls

C. Guiding Principles Items to be incorporated during Construction:

1. Commissioning
2. Low-emitting Materials
3. Air Quality during Construction
4. Recycled Content
5. Bio-based Content
6. Environmentally Preferable Products
7. Waste and Materials Management
8. Ozone Depleting Compounds

1.2 DEFINITIONS

A. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

B. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Fermilab regarding Guiding Principles Construction Items that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures. Document responses as informational submittals.

1.4 ACTION SUBMITTALS

A. General: Compliance with the requirements of the Guiding Principles goals shall be clearly indicated on the action submittals required by other Specification Sections.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Provide products and procedures necessary to comply with Guiding Principles outlined in this Section. Although other Sections may specify some requirements that contribute to compliance with the Guiding Principles, the Contractor shall determine additional materials and procedures necessary to comply.

2.2 COMMISSIONING

A. Objective: To employ commissioning tailored to the building, including commissioning requirements in construction documents, a commissioning plan, verification and a final report.

B. Implementation:

1. Refer to specification section 01815 – General Commissioning Requirements
2. Refer to Specification section 15995 – Commissioning of HVAC Systems

2.3 LOW-EMITTING MATERIALS

A. Objective: Use materials and products inside the weatherproofing system of the building that have low pollutant emissions, including composite wood products, adhesives, sealants, interior paints and finishes, carpet systems, and furnishings.

B. Implementation: All submittals

1. Adhesives and Sealants shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

a) Wood Glues: 30 g/L.
b) Metal-to-Metal Adhesives: 30 g/L.
c) Adhesives for Porous Materials (Except Wood): 50 g/L.
d) Subfloor Adhesives: 50 g/L.
e) Plastic Foam Adhesives: 50 g/L.
f) Carpet Adhesives: 50 g/L.
g) Carpet Pad Adhesives: 50 g/L.
h) VCT and Asphalt Tile Adhesives: 50 g/L.
i) Cove Base Adhesives: 50 g/L.
j) Gypsum Board and Panel Adhesives: 50 g/L.
k) Rubber Floor Adhesives: 60 g/L.
l) Ceramic Tile Adhesives: 65 g/L.
m) Multipurpose Construction Adhesives: 70 g/L.
n) Fiberglass Adhesives: 80 g/L.
o) Contact Adhesive: 80 g/L.
p) Structural Glazing Adhesives: 100 g/L.
q) Wood Flooring Adhesive: 100 g/L.
r) Structural Wood Member Adhesive: 140 g/L.
s) Single-Ply Roof Membrane Adhesive: 250 g/L.
t) Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
u) Top and Trim Adhesive: 250 g/L.
v) Plastic Cement Welding Compounds: 250 g/L.
w) ABS Welding Compounds: 325 g/L.
x) CPVC Welding Compounds: 490 g/L.
y) PVC Welding Compounds: 510 g/L.
z) Adhesive Primer for Plastic: 550 g/L.
aa) Sheet-Applied Rubber Lining Adhesive: 850 g/L.
bb) Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
cc) Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
dd) Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
ee) Other Adhesives: 250 g/L.
ff) Architectural Sealants: 250 g/L.
gg) Nonmembrane Roof Sealants: 300 g/L.
hh) Single-Ply Roof Membrane Sealants: 450 g/L.
ii) Other Sealants: 420 g/L.
jj) Sealant Primers for Nonporous Substrates: 250 g/L.
kk) Sealant Primers for Porous Substrates: 775 g/L.
ll) Modified Bituminous Sealant Primers: 500 g/L.
mm) Other Sealant Primers: 750 g/L.

2. Paints and Coatings shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    a) Categories in subparagraphs below are taken from LEED rating systems and the standards referenced by them; if clarification is required, see those documents or the reference guides.
    b) Flat Paints and Coatings: VOC not more than 50 g/L.
    c) Nonflat Paints and Coatings: VOC not more than 150 g/L.
    d) Dry-Fog Coatings: VOC not more than 400 g/L.
    e) Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
    f) Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
    g) Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
    h) Pretreatment Wash Primers: VOC not more than 420 g/L.
    i) Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
    j) Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
    k) Floor Coatings: VOC not more than 100 g/L.
    l) Shellacs, Clear: VOC not more than 730 g/L.
    m) Shellacs, Pigmented: VOC not more than 550 g/L.
    n) Stains: VOC not more than 250 g/L.

3. Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.
    a. Also refer to section 06412 Plastic Laminate Faced Architectural Cabinets and section 06417 – Plastic Laminate Clad Countertops.

2.4 AIR QUALITY DURING CONSTRUCTION

A. Objective: Follow Sheet Metal and Air Conditioning Contractor's National Association Indoor Air Quality Guidelines 2007. Continue after construction for 72 hours.

B. Implementation:

1. Refer to specification section 01572 – Indoor Air Quality During Construction

2.5 RECYCLED CONTENT OF MATERIALS

A. Objective: Building materials shall have recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content for Project constitutes a minimum of 10, but possibly as much as 20 percent of cost of materials used for Project.

1. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Do not include **furniture,** plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

B. Implementation: Select suppliers and vendors for the following materials that will make the project meet the target:

1. Cast-in-Place Concrete
2. Concrete Reinforcing
3. Structural and Miscellaneous Steel
4. Metal Wall and Roofing Systems
5. Metal Doors and Frames
6. Glazing
7. Aluminum Framed Windows and Curtain-walls
8. Metal Stud Framing
9. Gypsum Board

C. Additional Requirements in specific sections:
1. Refer to section 02370 – Erosion Control – for Riprap
2. Refer to section 09580 – Suspended Decorative Grid Ceiling.

2.6 BIOBASED CONTENT

A. Objective: Use Building materials that use biobased carbon content in lieu of fossil carbon content (coal or petroleum).

B. Implementation: Select suppliers and vendors for the following materials that will make the project meet the target:

1. Paving and Concrete Forming
2. Lumber and Millwork
3. Paintings and Coatings
4. Sealants

2.7 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Objective: Use Building materials that have less impact on human health and the environment over their lifecycle.

B. Implementation: Refer to sections above:

1. Low-emitting Materials
2. Recycled Material Content
3. Biobased content

2.8 WASTE AND MATERIALS MANAGEMENT

A. Objective: Recycle at least 50% of Construction waste during construction.

B. Implementation:

1. Refer to section 01524 – Construction Waste Management and Recycling.

2.9 OZONE DEPLETING COMPOUNDS

A. Objective: Eliminate the use of ozone-depleting compounds during and after construction. Do not use materials containing CFC or HCFC compounds. Do not use equipment using CFC refrigerants.

B. Implementation:

1. Refer to section 07413 – Insulated-Core Metal Wall Panels
2. Refer to section 15083 – HVAC Insulation
3. Refer to section 15085 – Plumbing Piping Insulation
4. Refer to section 15427 – Pressure Water Coolers
5. Refer to section 15732 – Packaged, Outdoor, Central-Station Air-Handling Units

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01810

SECTION 01815 - GENERAL COMMISSIONING REQUIREMENTS

PART 1. GENERAL

1.01 RELATED DOCUMENTS

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

B. Refer to other Division 1 Specification Sections, for related requirements which apply to this Section

C. Refer to other technical specification such Testing, Adjusting, balancing (TAB), commissioning, operation and maintenance manual, and Owner training requirements which apply to this Section

1.02 SUMMARY / PLAN REQUIREMENTS

A. Each subcontractor shall perform the commissioning activities for the systems, equipment and materials they install. When the equipment and materials are part of a larger system, each Subcontractor shall commission their portion of the work as part of the overall system commissioning. The commissioning activities will be coordinated by the Commissioning Authority. Perform the commissioning activities as outlined in Part 3, "Execution". Where terms, procedures, forms, etc. are indicated in this specification, the requirements for such items shall be as described in the Sample Commissioning Plan.

B. Perform commissioning activities on the following building energy-related equipment and systems.

1. HVAC Systems and Equipment

2. Domestic Hot Water System

3. Electrical Lighting Controls System.

1.03 SUBMITTALS

A. Provide the Commissioning Authority with the lists, forms, drawings, plans, reports, and manuals described in Part 3, "Execution".

1.04 SUBCONTRACTOR'S RESPONSIBILITIES

A. Assign a Subcontractor's Commissioning Project Manager ("CxPM"). The CxPM shall be assigned by the Subcontractor and shall be an employee of the Subcontractor. The CxPM shall serve as the construction team's single point of contact for the Commissioning Authority ("CxA"). It shall be the

CxPM's responsibility to ensure that all required parties, including technical representatives of equipment vendors, are present at commissioning related effort when required by this specification and/or when requested by the CxA. The CxPM shall witness all commissioning activities and shall initial commissioning forms to indicate satisfactory completion.

B. Assemble and provide a Subcontractor's commissioning team. The Subcontractor's commissioning team shall consist of: the Contractor's Commissioning Project Manager ("CxPM"), plus the Project Manager for the controls vendor, plus designated representatives of piping, sheet metal, electrical, and plumbing sub-subcontractors; The commissioning team shall include representatives of Subcontractor, including the Project superintendent and sub-subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

C. Subcontractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.

D. Attend commissioning team meetings.

E. Organize and maintain Commissioning activities log

F. Integrate and coordinate commissioning process activities with construction schedule.

G. Review and accept construction checklists provided by the CxA.

H. Complete electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.

I. Review and accept commissioning process test procedures provided by the Commissioning Authority.

J. Complete commissioning process test procedures.

1.05 CxA's RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Provide oversight to insure compliance with the commissioning plan.

C. Convene commissioning team meetings.

D. Provide Project-specific construction checklists and commissioning process test procedures.

E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.

F. Prepare and maintain the Issues Log.

G. Prepare and maintain completed construction checklist log.

H. Witness systems, assemblies, equipment, and component startup.

I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

PART 2. PRODUCTS (Not Used)

PART 3. EXECUTION

3.01 COMMISSIONING ACTIVITIES

A. The Commissioning Authority (CxA) will maintain a Commissioning Manual and Issues log.

B. The Contractor's Commissioning Project Manager (CxPM) shall organize and maintain Commissioning (Cx) activities.

C. The CxPM shall obtain all documentation related to the commissioning effort, and submit same to CxA.

D. Each Subcontractor shall provide their own contact information and a complete list of trade contractor, major manufacturer and major supplier contact information for inclusion in the Commissioning Manual.

E. CxA will develop project-specific commissioning forms for inclusion in the Manual. Each subcontractor shall complete, sign, and return the portion of each form that relates to their work. The types of forms required for this project include but are not limited to:

1. Contractor Pre-Inspection Forms

2. Functional Test Sheets.

3. Training Plans and Sign-In Sheets.

F. CxPM shall provide one copy of the following documents to the Commissioning Authority for systems or equipment being commissioned when such tests are required by other specification sections:

1. Manufacturers' factory test reports.

2. Field inspection and test reports.

3. Manufacturers' check-test-start reports.

G. The Controls subcontractor through CxPM shall provide a detailed list of every control point installed. Include, in checklist format, a detailed procedure to verify all aspects of the controls' operational sequence.

H. During the shop drawing submittal process, CxPM shall submit one set of shop drawings for all systems and equipment being commissioned to CxA. The shop drawings shall be submitted at the same time they are submitted to the A/E for review.

I. CxPM shall provide to the Commissioning Authority installation manuals for the systems and equipment being commissioned:

J. Soon after construction starts, CxPM shall submit one draft Operation and Maintenance (O&M) Manual for approval in accordance with the related specification section.

K. CxPM shall provide advance notification of the following activities:

1. At least 2 weeks advance notice of duct leak tests.

2. At least 2 weeks advance notice of pipe leak tests.

3. At least 2 weeks advance notice of pipe flushings /cleanings.

4. At least 1 week advance notice of Manufacturer check-test- starts.

5. At least 2 weeks advance notice of functional tests.

6. At least 2 weeks advance notice of Owner training sessions.

L. CxPM shall submit electrical test reports for approval at least 1 week prior to equipment energization.

M. CxPM shall review, coordinate, confirm and schedule Contractor's Pre-Inspection work (CPI) or system verification, with subcontractor and commissioning team. CxPM shall log and correct any deficiencies and shall sign the CPI form to confirm completion.

N. Each subcontractor, in coordination with CxPM, shall check, test, and start up each system in accordance with the Manufacturer's instructions.

1. The Pre-Start Check Sheets shall be submitted and approved prior to starting up systems and equipment. This applies both to early starts for construction use and to full startups before functional testing.

2. Where required by the Project Specifications or by the Manufacturer, startup shall be performed by a Manufacturer's Representative. Provide a copy of the completed equipment start up form used by the Manufacturer's Representative during start up.

O. CxPM shall submit the Testing, Adjusting and Balancing (TAB) outline to CxA and coordinate with controls subcontractor.

P. At the same time they are submitted to the A/E for review, submit a copy of each Air and Water Balance Test Report to the Commissioning Authority for review.

Q. shall be submitted after completion of the each TAB work.

R. Subcontractors shall prove each system is fully functional in all modes of operation. CxPM shall coordinate with other trades so all modes of operation can be demonstrated. Each subcontractor shall demonstrate the portion of the work they provided.

1. Test each system component, zone, and control sequence.

2. Test under both full and partial loads.

3. Test under normal, abnormal, and emergency conditions.

4. Test under design basis seasonal conditions.

S. Subcontractors and CxPM shall correct the incomplete and non-conforming items that were identified during the commissioning process.

1. Deficiencies that affect system operation must be corrected prior to functional testing.

2. Deficiencies discovered during or after functional testing must be corrected prior to acceptance of the systems by the Commissioning Authority.

T. CxPM shall provide four approved O&M Manuals in accordance with the related specification section a minimum of two weeks prior to scheduled Owner training.

U. CxPM shall arrange for and participate in Owner training sessions for the systems and equipment being commissioned.

1. Coordinate with the CxA and provide a master list of all training sessions in advance of the first training session. Identify the systems and equipment that will be covered in each session.

2. Define each training session as either over view training or specific system/ equipment training.

a) Overview training shall provide the design intent and general operation of each system and its equipment, including interactions with other systems and equipment.

b) Specific system/equipment training shall include the overview followed by more detail. Specific system/equipment training only applies when special training requirements are referenced in other Technical Specification Sections.

3. Schedule the time and location of each training session after the system and equipment have passed functional testing, and after final approved O&M Manuals have been provided to the Owner.

a) Conduct the training at the system or equipment. For specific sys-

tem /equipment training, also conduct classroom training when specified or appropriate.

b) In conjunction with the Commissioning Authority, provide overview training on the system or equipment.

c) Review the contents of the O&M Manual as it relates to the Training Session.

d) Walk down each system with the Trainees. Indicate the locations and explain the operation of basic system components such as isolation valves, drains, vents, expansion compensators, distribution piping, flow meters, electrical panels, motor controls, disconnects, lighting controls, fire alarm and security devices, roof hatch access, etc.

e) For specific system/equipment training, also provide the following:

f) Meanings of alarms, indicators, and warning signs.

g) Operating procedures under all normal, abnormal and emergency modes of operation.

h) Maintenance procedures including cleaning, lubricating and adjustment procedures.

i) Inspection, troubleshooting and repair procedures.

j) After each training session, provide a copy of the agenda and completed sign-in sheet to the Commissioning Authority.

END OF SECTION 019113

SECTION 02100 - SITE PREPARATION

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Clearing, grubbing and stripping of vegetation from the construction site as specified.

1.02 RELATED SECTIONS

A. Section 02220 – Excavating for Structures, Pavements, and Utilities.

B. Section 02221 – Backfilling and Compacting for Structures, Pavements, and Utilities.

C. Section 02370 - Erosion Control.

D. Section 02500 – Roadways.

E. Section 02930 - Fertilizing and Seeding.

1.03 REFERENCE TO STANDARDS

A. Illinois Department of Transportation (IDOT); Standard Specifications for Road and Bridge Construction in Illinois, latest edition.

1.04 SUBMITTALS

A. No submittals are required in this section.

1.05 JOB CONDITIONS

A. Verify all locations, size and depths of existing services, in the presence of the Construction Coordinator, prior to any site work of any nature, in order to positively eliminate the possibility of accidentally cutting into any services.

B. Provide protection necessary to prevent damage to existing improvements indicated to remain in place.

C. Restore damaged improvements to their original condition, as acceptable to Construction Coordinator.

D. Provide protection of property adjoining the project.

PART 2. PRODUCTS OR MATERIALS

2.01 Not Applicable.

PART 3. EXECUTION

3.01 PREPARATION

A. Do not interrupt existing utilities serving facilities occupied and used by Fermilab or others except when permitted in writing by Fermilab and then only after acceptable temporary utility services have been provided. Provide minimum of forty-eight (48) hours notice prior to enacting an approved temporary interruption.

3.02 CLEARING

A. The Subcontractor shall examine the site to determine the extent of clearing work required.

B. The site shall be cleared of trees and brush within the construction limits that are necessary to complete the work. No attempt has been made to show the number of trees on the plans.

3.03 GRUBBING

A. All stumps of trees and brush removed shall be grubbed to at least 2’ below existing grade. This includes stumps that remain as a result of previous work in this area.

B. Areas that will not be further disturbed on this project shall be restored to grade with stripped material from the site.

3.04 STRIPPING TOPSOIL

A. Stripping of the vegetation and topsoil is required. Topsoil shall be removed from all building, pavement and embankment areas a minimum of 5’ in all directions beyond the limits of the structure, pavement and embankment. Any area used as a source of fill should also be stripped of topsoil. Stripping depth shall be a minimum of 6”.

B. The Subcontractor shall coordinate location and stockpile topsoil and finish grade material at the site to be used when the site construction is complete. Construct storage piles to freely drain surface water. Cover storage piles to prevent windblown dust.

3.05 BURNING

A. Burning of trees and brush will not be allowed on the site.

3.06 PROTECTION

A. Existing valve boxes and manholes shall be protected so they will not be crushed, buried with earth or covered with construction material and made inaccessible.

3.07 SURVEY, LAYOUT, LINES AND GRADE

A. Perform all survey, layout, staking and marking to establish and maintain all lines, grades, elevations and benchmarks needed for execution of the work shown on the drawings.

B. Relate survey layout to the coordinate grid system, elevation datum, and related survey control points and benchmarks established by Fermilab.

C. The above survey and related work shall be performed in a timely manner relative to the other work of the subcontract.

D. Inform the Fermilab Construction Coordinator immediately of any inconsistencies.

END OF SECTION 02100

SECTION 02220 - EXCAVATING FOR STRUCTURES, PAVEMENTS, AND UTILITIES

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Excavation, stripping and stockpiling of existing earth materials and dewatering of excavations as required under the project.

1.02 RELATED SECTIONS

A. Section 02100 - Site Preparation.

B. Section 02221 – Backfilling & Compacting for Structures & Pavements.

C. Section 02230 – Embankment.

D. Section 02500 – Roadways.

E. Section 02370 - Erosion Control.

1.03 REFERENCE TO STANDARDS

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

B. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction in Illinois, latest edition.

C. Occupational Safety and Health Administration (OSHA): Current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successive regulations.

1.04 REGULATORY REQUIREMENTS

A. Codes and Standards:

1. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

2. Prior to the commencement of construction, the Subcontractor shall be aware of, and become familiar with applicable local, state and federal safety regulations, including the current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successive regulations.

3. Additionally, the Subcontractor shall be aware that slope height, slope inclination and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state or federal safety

regulations.

1.05 COORDINATION

A. Do not interrupt existing utilities serving facilities occupied and used by Fermilab or others except when permitted in writing by Fermilab and then only after acceptable temporary utility services have been provided. Provide minimum of forty-eight (48) hour notice prior to enacting an approved temporary interruption.

PART 2. PRODUCTS (RESERVED)

PART 3. EXECUTION

3.01 EXAMINATION

A. Site Information:

1. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Fermilab will not be responsible for interpretations or conclusions drawn therefrom by Subcontractor. Data are made available for convenience of Subcontractor.

2. Subcontractor shall be responsible for determining the actual ground water elevation and soil conditions at the specific site prior to commencing with the excavation.

3. It may be expedient to drill auger holes, excavate test pits or make additional soil borings at or adjacent to the construction area immediately prior to construction to determine the prevailing soil conditions and water table elevation.

4. It is the Subcontractor's responsibility to make auger holes, excavate test pits or make additional soil borings as he deems appropriate to determine the ground water and soil conditions that will be encountered.

5. Additional test borings and other exploratory operations made by the Subcontractor shall be at no cost to Fermilab.

3.02 PREPARATION

A. Establish extent of excavated areas.

B. Set specified lines and levels.

C. Maintain benchmarks, monuments and other reference points.

D. Before starting excavation, establish location and extent of underground utilities

occurring in work area and contact Construction Coordinator.

E. Maintain, reroute or extend existing utility lines to remain which pass through work area and are to remain in service.

3.03 EXCAVATION

A. General:

1. Excavation consists of removal and redistribution of material encountered when establishing required grade and subgrade elevations and cross sections.

2. The Subcontractor is solely responsible for designing and constructing stable excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations shall comply with applicable local, state and federal safety regulations including the current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successive regulations.

3. All sheeting, shoring and bracing of trenches, pits and excavations shall be the sole responsibility of the Subcontractor. Limits of braced excavation showing on drawings are schematic and should be verified by Subcontractor.

4. Construction site safety is the sole responsibility of the Subcontractor, including but not limited to, the means, methods, and sequencing of construction operations.

5. Earth excavation consists of removal and disposal of pavements and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of any classification indicated in data on sub-surface conditions, and other materials encountered that are not classified as unauthorized excavation.

B. Unauthorized Excavation:

1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Construction Coordinator. Unauthorized excavation, as well as remedial work directed by Construction Coordinator, shall be at Subcontractor's expense.

2. Lean concrete fill may be used to bring elevations to proper position, only when acceptable to Construction Coordinator.

3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of the same classification, unless otherwise directed by Construction Coordinator.

C. Additional Excavation:

1. When excavation has reached required sub-grade elevations, notify Construction Coordinator who will make an inspection of conditions.

2. If unsuitable bearing materials are encountered at required sub-grade elevations, carry excavations deeper and replace excavated material as directed by Construction Coordinator.

3. Removal of unsuitable material and its replacement as directed will be paid on basis as directed by the Construction Coordinator.

D. Dewatering:

1. Prevent surface water and subsurface or ground water from flowing into excavation and from flooding project site, existing basement, and surrounding area.

2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

4. All water removed from excavations shall be directed to temporary sediment basins.

E. Material Storage:

1. Stockpile satisfactory excavated materials in the location designated on the drawings or as otherwise indicated by Fermilab's Construction Coordinator, until required for backfill or fill.

2. Place, grade and shape stockpiles for proper drainage.

3. Locate and retain soil materials away from edge of excavations.

4. Contain excavated silt/soil runoff with straw wattles and silt fences as directed by the Construction Coordinator and in accordance with Local, State and Federal Requirements as directed by the Construction Coordinator and in accordance with Section 02370 of these specifications.

5. Topsoil shall be segregated from other materials and stockpiled for use in landscaping. Any surplus topsoil shall be disposed of by the Subcontractor as directed by the Construction Coordinator.

F. Excavation for Structure:

1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction and for inspection.

2. In excavating for footings and foundations, take care not to disturb bottom of excavation.

3. Excavate by hand or smooth bladed backhoe to final grade just before lean concrete mud slab base is placed.

4. Trim bottoms to required lines and grades to leave solid base to receive other work.

5. After completion of excavation and prior to placement of concrete for footings, excavations shall be inspected and approved by the Construction Coordinator to ensure that suitable bearing has been obtained. Twenty-four (24) hours notice shall be given to Construction Coordinator.

6. Fill excess cuts under footings and foundations with a minimum of 12" of IDOT CA-6 Class C quality or better compacted to 98 percent Standard Proctor density in accordance with ASTM D698.

G. Excavation for Utility Trenches

1. Excavate trenches to required gradients, lines, depths, and elevations.

2. Excavate trenches to uniform widths to provide 12" of clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12" higher than top of pipe or conduit unless otherwise indicated.

3. Excavate trench bottoms 4" deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

H. Excavation near Utilities:

1. All excavations within 2' of existing utilities shall be excavated by hand.

2. Protect, support, shore, brace, etc. all utility services uncovered by excavation.

3. Accurately locate and record abandoned and active utility lines rerouted or extended, on Project Record Documents.

4. Repair damaged utilities to the satisfaction of the Construction Coordinator.

I. Disposal of Excess and Waste Materials:

1. Removal from Fermilab's Property:

a) Waste materials, trash and debris shall become the subcontractor's property and he/she shall legally dispose of it off Fermilab's property.

2. Excess Material:

a) Excess excavated material shall be transported and placed in locations on Fermilab's property as directed by the Construction Coordinator.

3.04 FIELD QUALITY CONTROL

A. The Subcontractor shall allow bearing surfaces at the bottom of excavations to be inspected by the Construction Coordinator, and shall modify the bearing surfaces as requested by the Construction Coordinator, prior to placement of any base materials.

3.05 PROTECTION

A. Stability of Excavation:

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction.

2. Shore and brace where sloping is not possible either because of space restrictions or stability of material excavated.

3. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

4. Comply with current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successive regulations.

B. Cold Weather Protection:

1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F (1°C).

C. Protection of Persons and Property:

1. Fence and barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required by authorities having jurisdiction.

2. Protect structures, landscaping, utilities, sidewalks, pavements or other facilities from damage caused by settlement, lateral movement,

undermining, washout and other hazards created by earthwork operations.

3. Comply with current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.

END OF SECTION 02220.

SECTION 02221 - BACKFILLING AND COMPACTING FOR STRUCTURES, PAVEMENTS, AND UTILITIES

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling and compaction of soil and aggregate material.

B. Rough grading.

C. Preparation of subgrade for slabs and installation of footings.

1.02 RELATED SECTIONS

A.	Section 02220	Excavating for Structures, Pavements and Utilities.
B.	Section 02370	Erosion Control
C.	Section 02930	Fertilizing and Seeding

1.03 REFERENCE TO STANDARDS

A. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/ft3).

B. ASTM D4253 - Maximum Index Density and Unit Weights of Soils Using a Vibratory Table.

C. Illinois Department of Transportation (IDOT); Standard Specifications for Road and Bridge Construction in Illinois, latest edition

1.04 SUBMITTALS

A. Submit under the direction of Fermilab Construction Coordinator.

B. Submit copies of Standard Proctor Density Test results to Construction Coordinator a minimum of seven (7) business days prior to backfilling any excavations.

1.05 QUALITY ASSURANCE

A. Compaction Testing:

1. Standard Proctor Density Testing and Compaction Testing of fill materials and inspection of subgrades and fill layers shall be performed by the Subcontractor ' s testing service, using Proctor information furnished by the Subcontractor.

2. If in the opinion of Construction Coordinator, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense to Fermilab.

3. When, during progress of work, tests indicate that compacted materials will not meet specifications, remove defective work, the Subcontractor shall replace and retest at no additional cost to Fermilab.

4. The Subcontractor shall ensure that all compacted fills are tested and meet specified standards before proceeding with placement of surface materials.

PART 2. PRODUCTS

2.01 DEFINITIONS

A. Suitable Soil:

1. Suitable soil is a soil having less than 5 percent organic matter by weight as determined by the Loss on Ignition Test (determine weight loss caused by heating sample to 500°C for six (6) hours after drying in accordance with ASTM D-2216, "Laboratory Determination of Moisture Content of Soil").

B. Unsuitable Soil:

1. Unsuitable soil is a soil that contains 5 percent or more organic matter as determined by the Loss of Ignition Test previously specified. Rubbish, vegetation matter of every kind, roots, and boulders larger than 5 in. in dimension which might interfere with the proper bonding to adjacent contact surfaces, or as otherwise determined unsuitable by the Construction Coordinator.

C. Cohesive Soil:

1. Cohesive soil is a soil containing more than 50 percent fine material passing the No. 200 standard sieve, and with more than 15 percent clay-size particles smaller than 0.002 mm (2 microns). The soil matrix passing the No. 40 standard sieve exhibits dry (crushing) strength in the dry state and cohesive shear strength in the moist state, as well as being plastic in the moist state.

2.02 BACKFILL MATERIALS

A. Base Materials:

1. Where indicated on drawings, IDOT CA-6 crushed limestone Class C Quality, minimum of 12” in depth unless otherwise shown.

B. Fill and Base Materials - Asphalt Pavement Area:

1. Granular fill or base materials below the proposed parking and roadways will be IDOT CA-6 crushed limestone Class C Quality.

C. Fill and Base Materials - Hardstand Area:

1. Granular fill or base materials below the proposed hardstand area shall be IDOT CA-6 crushed limestone class C quality and IDOT CA-1.

D. Finish Grading:

1. See Section 02230 - Embankment for more information.

PART 3. EXECUTION

3.01 EXAMINATION

A. Prior to placement of any fill or backfill and prior to placement of all subsequent fill lifts, Subcontractor shall contact an independent testing laboratory for inspection and testing of excavation subgrade and testing of each compacted layer of fill and backfill material. The Subcontractor shall be responsible for all testing costs.

B. Name of testing firm chosen by Subcontractor shall be submitted to the Construction Coordinator for approval prior to beginning compaction work.

C. The Subcontractor shall provide Proctor information necessary to perform density testing on in-place backfill material.

3.02 PREPARATION

A. Backfilling and compaction shall not occur until the following conditions are satisfied:

1. Acceptance by Construction Coordinator of construction below finish grade including, where applicable, dampproofing and rigid insulation.

2. Inspection, testing, approval and recording locations of underground utilities.

3. Removal of concrete formwork.

4. Removal of trash and debris, vegetation, snow or ice, water, unsatisfactory soil materials, obstructions and deleterious materials.

5. Removal of shoring and bracing and backfilling of voids with satisfactory material.

6. Ensure that ground surface within excavated area to be backfilled is not

frozen.

7. When existing ground surface has a density less than that specified under Article 3.03-C of this Section for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content and compact to required depth and percentage of maximum density.

3.03 BACKFILLING AND COMPACTING

A. General:

1. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below:

a) In existing lawn areas, use satisfactory excavated or borrowed exterior fill material.

b) Building related, use base material as indicated.

B. Placement and Compaction:

1. Place backfill, base and fill materials in layers not more than 8”. in loose depth for material compacted by heavy compaction equipment and not more than 4”. in loose depth for material compacted by hand operated tampers.

2. Heavy equipment including compaction equipment shall not operate within 2’ of unbraced substructure walls.

3. Compaction in areas within 2’ of unbraced substructure walls shall be obtained with hand operated compaction equipment or devices.

4. Earth backfill and native soil backfill shall be compacted with sheepsfoot compaction equipment complying with sequencing, lift-height, and weight limitations.

5. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content.

6. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.

7. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice.

8. Place backfill and fill materials evenly adjacent to structure to required elevations.

9. Take necessary precautions to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

C. Percentage of Maximum Density Requirements:

1. Unless otherwise noted on the plan sheets, the Subcontractor shall compact each layer of soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D698, Standard Proctor Compaction Test; and not less than the following percentages of relative density, determined in accordance with ASTM D4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils):

a) Base Materials for Other Footings and Slabs:

2. Compact top 12” of subgrade and each layer of backfill or fill material to 98 percent of the Standard Proctor density for cohesive material or to 98 percent relative density for cohesionless soils.

a) Paved Areas:

1) Compact top 12” of subgrade and each layer of backfill or fill material to 95 percent of the Standard Proctor density for cohesive material or 90 percent of the relative density for cohesionless soils.

b) Lawn or Unpaved Areas:

1) Compact top 6” of subgrade and each layer of backfill or fill material to 90 percent relative density for cohesionless soils and to 95 percent Standard Proctor density for cohesive soil materials.

D. Moisture Control:

1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water top surface or subgrade or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.

2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

E. Grading:

1. General:

a) Uniformly grade areas within limits of excavation under this Section, including adjacent transition areas. Compact with uniform levels or slopes between such points and existing grades.

b) Remove stones over 1-1/2". in any dimension and sticks, roots, rubbish and other extraneous matter.

c) Rough grade to 6" below finish, grades and elevations indicated in the drawings.

d) Grading Outside Structure Lines:

1) Grade areas adjacent to building lines to drain away from structures and to prevent ponding.

2) Finish surfaces free from irregular surface changes, and as follows:
a. Slabs: Shape surface of areas under slabs to line, grade and cross-section, with finish surface not more than ½" above or below required subgrade elevation.

2. Compaction:

a) After grading, compact subgrade surfaces to the depth and percentage of maximum or relative density for each area classification.

F. Maintenance:

1. Protection of Graded Areas:

a) Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

b) Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

2. Reconditioning Compacted Areas:

a) 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.

3. Settling:

a) Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill 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.

b) The Subcontractor shall perform above stated work at no additional cost to Fermilab.

3.04 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Revise dimensions or extent of concrete backfill in first two paragraphs below to suit Project.

D. Trenches under Roadways: Provide 4” thick, concrete-base slab support for piping or conduit less than 30” below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4” of concrete before backfilling or placing roadway subbase course.

E. Backfill voids with suitable soil while removing shoring and bracing.

F. Place and compact initial backfill of suitable soil, free of particles larger than 1” (25 mm) in any dimension, to a height of 12” over the pipe or conduit.

G. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

H. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12” over the pipe or conduit. Coordinate backfilling with utilities testing.

I. Place and compact final backfill of suitable soil to final subgrade elevation.

3.05 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction:

1. Allow the Construction Coordinator to inspect subgrades and fill layers before further construction work is performed.

2. If in opinion of Construction Coordinator, based on field density testing and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense to Fermilab.

END OF SECTION 02221

SECTION 02230 - EMBANKMENT

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Establishing of the embankment indicated in the drawings for the Mu2e Building. Construction of the embankment shall consist of depositing, placing and compacting, where indicated, earth, or other materials of acceptable quality (suitable soil).

B. The work shall include transporting and spreading material, moisture control, compaction, fine grading and all other incidental work associated with the construction of the embankment.

C. Materials for embankment shall consist of excavated materials from the construction area and borrow material (if required) from an acceptable source. Maintain segregation of topsoil and clay material stockpiles.

1.02 RELATED SECTIONS (RESERVED)

1.03 REFERENCE TO STANDARDS

A. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).

B. ASTM D4253 - Maximum Index Density and Unit Weights of Soils Using a Vibratory Table.

C. Illinois Department of Transportation (IDOT); Standard Specifications for Road and Bridge Construction in Illinois, latest edition.

1.04 SUBMITTALS

A. Submit Shop Drawings and Material Samples.

B. Submit copies of Standard Proctor Density Test results to Construction Coordinator a minimum of seven (7) business days prior to backfilling any excavations.

1.05 QUALITY ASSURANCE

A. Compaction Testing:

1. Standard Proctor Density Testing and Compaction Testing of fill materials and inspection of subgrades and fill layers shall be performed by the Subcontractor's testing service, using Proctor information furnished by the Subcontractor.

2. If in the opinion of Construction Coordinator, based on testing service reports and inspection, embankment materials or fills which have been placed are below specified density, the Subcontractor shall provide additional compaction and testing at no additional expense to Fermilab.

3. When, during progress of work, tests indicate that compacted materials will not meet specifications, remove defective work, the Subcontractor shall replace and retest at no additional cost to Fermilab.

4. The Subcontractor shall ensure that all compacted embankment materials are tested and meet specified standards before proceeding with placement of surface materials.

PART 2. PRODUCTS

2.01 EMBANKMENT MATERIALS

A. Existing excavated stiff silty and sandy clay will be acceptable as embankment material and is to be utilized where shown on the drawings.

PART 3. EXECUTION

3.01 EXAMINATION

A. The Subcontractor shall make arrangements with an independent laboratory for inspection and testing of each compacted layer of embankment and shall pay for those tests.

B. Name of testing firm chosen by Subcontractor shall be submitted to the Construction Coordinator for approval prior to beginning compaction work.

C. The Subcontractor shall provide Proctor information necessary to perform density testing on embankment material.

3.02 PREPARATION

A. Embankment placement and compaction shall not occur until the following conditions are satisfied:

1. Acceptance by Construction Coordinator of construction below finish grade including, where applicable, dampproofing.

2. Inspection, testing, approval and recording locations of underground utilities.

3. Removal of concrete formwork.

4. Removal of trash and debris, vegetation, snow or ice, water, unsatisfactory soil materials, obstructions and deleterious materials.

5. Removal of shoring and bracing and backfilling of voids with satisfactory material.

6. Ensure that ground surface within embankment area is not frozen.

7. When existing ground surface has a density less than that specified under Article 3.03-C of this Section for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content and compact to required depth and percentage of maximum density.

3.03 EMBANKMENT PLACEMENT AND COMPACTING

A. General:

1. Place embankment material in layers to required subgrade elevations indicated on the drawings.

2. Disk each layer sufficiently to break down oversize clods to a maximum of 4".

B. Placement and Compaction:

1. Place embankment materials in layers not more than 8" in loose depth for material compacted by heavy compaction equipment and not more than 4" in loose depth for material compacted by hand operated tampers.

2. Heavy equipment including compaction equipment shall not operate within the limitations indicated on the drawings.

3. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content.

4. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.

5. Do not place embankment material on surfaces that are muddy, frozen or contain frost or ice.

6. Place embankment materials evenly adjacent to structure to required elevations. Take necessary precautions to prevent wedging action of embankment against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

C. Percentage of Maximum Density Requirements:

1. The Subcontractor shall compact each layer of soil to not less than the percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D698, Standard Proctor Compaction Test; and not less than the following percentages of relative density, determined in accordance with ASTM D4253, for soils which will not exhibit a well-defined moisture-

density relationship (cohesion less soils):

2. Paved Areas:

   a. Compact each layer of backfill or fill material to 95 percent of the Standard Proctor density for cohesive material or 90 percent of the relative density for cohesion less soils.

3. Lawn or Unpaved Areas:

   a. Compact top 6” of subgrade and each layer of backfill or fill material to 90 percent relative density for cohesion less soils and to 95 percent Standard Proctor density for cohesive soil materials.

D. Moisture Control:

1. When layers of soil material must be moisture conditioned before compaction, uniformly apply water to top surface or subgrade of soil material, to prevent free water from appearing on surface during or subsequent to compaction operations.

2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

E. Grading:

1. General:

   a. Uniformly grade areas within limits of embankment under this Section, including adjacent transition areas. Compact with uniform levels or slopes between such points and existing grades.

   b. Remove stones over 1-1/2” in any dimension and sticks, roots, rubbish and other extraneous matter.

   c. Rough grade to 6” below finish grades and elevations indicated in the drawings.

   d. Grading Outside Structure Lines:

      1) Grade areas adjacent to structure as indicated on the drawings.

2. Compaction:

   a. After grading, compact subgrade surfaces to the depth and percentage of maximum or relative density for each area classification.

F. Maintenance:

1. Protection of Graded Areas:

    a. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

    b. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

2. Reconditioning Compacted Areas:

    a. 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.

3. Settling:

    a. Where settling is measurable or observable at embankment areas during general project warranty period, remove surface (lawn or other finish), add embankment 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.

    b. The Subcontractor shall perform the above stated work at no additional cost to Fermilab.

3.04 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction

1. Allow the Construction Coordinator to inspect embankment before further construction work is performed.

2. If in opinion of Construction Coordinator, based on field density testing and inspection, embankment materials which have been placed are below specified density, The Subcontractor shall provide additional compaction and testing at no additional expense to Fermilab.

END OF SECTION 02230

SECTION 02311 - ROUGH GRADING

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Excavating topsoil and subsoil.

B. Cutting, filling, grading, and rough contouring the site for site structures and topsoil.

1.02 Related Sections

A. Section 02220 – Excavating for Structures, Pavements, and Utilities.

B. Section 02221 – Backfilling and Compacting for Structures, Pavements, and Utilities.

C. Section 02920 - Topsoil.

1.03 REFERENCES

A. ASTM International, (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. (12,400 ft-lbs/cu ft.) (600 kN-m/cu m).

3. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/cu ft (2,700 kN-m/cu m)).

4. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. Illinois Department of Transportation (IDOT); Standard Specification for Road and Bridge Construction in Illinois, latest edition.

C. Occupational Safety and Health Administration (OSHA): Current OSHA Standards-Excavations, 29 CFR Part 1926, including any successor regulations.

PART 2. PRODUCTS

2.01 MATERIALS

A. Unless other materials are specifically indicated for backfilling and filling, use soil materials excavated from site.

B. Render all backfill and fill materials free of rock or gravel larger than 2” in any dimension, debris, waste, frozen parts, vegetation and other deleterious matter.

PART 3. EXECUTION

3.01 EXAMINATION

A. Verify site conditions under the direction of the Fermilab Construction Coordinator.

B. Verify that survey benchmark and intended elevations for the Work are as indicated.

3.02 PREPARATION

A. Notify affected utility companies before starting work and comply with their requirements.

B. Mark location of all existing utilities. Protect from damage utilities indicated to remain.

C. Protect plant life, lawns and other features remaining as a portion of final landscaping.

D. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.03 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded.

B. Do not excavate wet subsoil, or excavate and process wet material to obtain optimum moisture content.

C. When excavating through roots is necessary, perform work by hand and cut roots with sharp axe.

D. Benching Slopes: Horizontally bench existing slopes greater than [1:4] to key placed fill material to slope to provide firm bearing.

E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 FILLING

A. Cut and fill areas to contours and elevations with specified materials.

B. Place fill material in maximum 8” thick layers. Compact to minimum 95 percent of maximum standard Proctor density

C. Do not place fill materials on surfaces that are muddy, frozen, or contain frost or ice.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Remove rock or gravel larger than 2” in any dimension, debris, waste, obstructions, and deleterious matter from ground surface prior to placement of fills.

F. Slope grade away from buildings minimum 2” in 10’, unless noted otherwise.

G. Make grade changes gradual. Blend slope into level areas.

H. Repair or replace items indicated to remain damaged by excavation or filling.

3.05 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10’

3.06 FIELD QUALITY CONTROL

A. Testing: In accordance with ASTM D2922. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

B. Frequency of Tests: One test for every 5000 sq. ft of area for each layer (lift) with a minimum of 2 tests per layer of fill.

END OF SECTION 02311

SECTION 02370 - EROSION CONTROL

PART 1.GENERAL

1.01 SECTION INCLUDES

A. Erosion control fabric fence, straw wattles, wattle stakes, rip rap, rock dams, temporary seeding and mulch, and wash down stations.

1.02 RELATED SECTIONS

A. Section 02100 – Site Preparation

B. Section 02221 – Backfilling and Compacting for Structures and Pavements

C. Section 02500 - Roadways

1.03 REFERENCE TO STANDARDS

A. Illinois Urban Manual

B. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge construction in Illinois, latest edition.

1.04 DESCRIPTION OF THE WORK

A. This work shall consist of constructing temporary and permanent erosion control systems, as shown on the plans or as ordered by the Construction Coordinator, during the life of the contract to control erosion and sediment damage to the adjacent properties and water resources through the use of temporary seeding, riprap, ditch checks, rock dams, erosion control fabric fence and inlet sedimentation control. The Subcontractor shall follow the provisions of the Illinois Urban Manual for general guidance when not specifically identified on the plans, in the specifications, or in the project specific SWPPP.

B. Any temporary erosion control methods ordered by the Construction Coordinator shall be coordinated with the permanent erosion control features specified elsewhere in the contract to the extent practical to assure economical, effective and continuous erosion control throughout the construction period.

PART 2. MATERIALS

2.01 EROSION CONTROL FABRIC FENCE

A. This fence shall conform to the requirements specified herein.

B. Geotextile fabric for silt fence shall consist of woven or nonwoven filaments of polypropylene, polyester or polyethylene. Nonwoven fabric may be needle punched, heat-bonded, resin-bonded or combination thereof. The filaments in the Silt Filter Fence Fabric must be dimensionally stable (i.e., to each other), resistant to delamination, and must be free from any chemical treatment or coating that might significantly reduce porosity and permeability. Both fabrics shall be resistant to ultraviolet radiation. The fabrics shall comply with the following physical properties.

Physical Properties	Silt Filter Fence Fabric
Grab Tensile Strength (lb) ASTM D 4632	200 min.
Grab Elongation @ Break (%) ASTM D 4632	12 min.
Burst Strength (psi) - ASTM D 3786	250 min.
Trapezoidal Tear Strength (lb) ASTM D 4533	75
Weight (oz/sq yd) – ASTM D 3776	4.0 min

For woven fabric, test results shall be referenced to orientation with warp or weave, whichever the case may be. Both woven and nonwoven fabric shall be tested wet. Test results may be obtained by manufacturer's certification.

C. The erosion control fabric fence shall be as shown on the construction plans or equal approved by the Construction Coordinator.

D. The fabric fence stakes shall be oak wood stakes with minimum dimensions of 1.125" x 1.125" x 42".

2.02 STRAW WATTLES

A. Shall be straw wattles approved by the Construction Coordinator compacted and adequately bound with manufacturer's netting.

B. Sediment traps shall be constructed and maintained to filter sediment from runoff, until the work under the Contract is complete. Additional diversion ditches may be constructed so that a maximum drainage area is diverted through the trap.

2.03 WATTLE STAKES

A. Shall be installed per manufacturer's specification.

2.04 RIPRAP

A. Riprap shall be CA-1 or CA-1 recycled concrete for culvert end sections and meets the requirements of Article 1005.01 of the IDOT Standard Specifications for Road and Bridge Construction.

B. Riprap shall meet the Quality and Gradation requirements listed on the plans per Article 1005.01 of the IDOT Standard Specification for Road and Bridge Construction.

C. Bedding material shall be crushed limestone meeting the requirements of Article 1005.01 of the IDOT Standard Specification for Road and Bridge Construction.

D. Filter fabric shall be as specified in Section 1080.03 of the IDOT Standard Specifications for Road and Bridge Construction.

E. Riprap shall be installed per the provisions of Section 281.04 of the IDOT Standard Specification for Road and Bridge Construction.

2.05 TEMPORARY SEEDING AND MULCHING

A. Temporary Seeding and Mulching shall be consistent with Article 880 of the Illinois Urban Manual. Seed Mixture shall be from Table A of said Article and shall be coordinated with Fermi Construction Coordinator for the planting season.

B. Note the provisions of paragraph 3.01 regarding seed mixture enhancements of cereal grains.

C. Hydroseeding shall be used.

D. Mulch shall be straw mulch and placed concurrently with the seeding operation or immediately following.

E. Provide straw mulch on all disturbed areas with slopes less than 3:1.

F. Provide erosion control blankets on all slopes of 3:1 or greater.

2.06 STRAW EROSION CONTROL BLANKET

A. The blanket shall consist of a machine produced mat of straw or combination of straw and coconut fiber and shall be furnished in rolls and meet the following minimum requirements:

1. Width - 66 inches, ± 1”.

2. Length - 83.5’.

3. Weight - 0.75 lbs. per sq. yd., ± 10 percent.

4. Material - not less than 70 percent straw.

5. The blanket shall be bound with a biodegradable cotton thread.

6. The top of each blanket shall be covered with photodegradable netting.

7. All material shall be new and unused and the length shall be marked on each roll.

B. "U" shaped wire staples of 0.12” in diameter (No. 11 wire gage) or greater, with minimum leg length of 6” and minimum crown of 1” shall be used. In sandy soils the minimum leg length of staples shall be 9”.

2.07 WASH DOWN STATIONS

A. Rock construction entrances and hose wash down stations shall be constructed as necessary.

B. Maintain rock construction entrances to prevent mud from being tracked onto the adjoining roads and streets.

PART 3. CONSTRUCTION METHODS

3.01 INSTALLATION - GENERAL

A. The Construction Coordinator has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to require the Subcontractor to provide immediate permanent or temporary pollution control measures.

B. Haul Roads shall be watered continuously during earth moving operations.

C. Cut slopes shall be permanently seeded and mulched as the excavation proceeds to the extent considered desirable and practical.

D. Slopes that erode easily shall be temporarily seeded as the work progresses with a cereal grain or wheat, rye or oats obtained from a local supplier or seed store. The cereal grains may be planted by a hand seeder or other acceptable method and covered by a drag or harrow to provide a quick cover crop. Inspection of the cereal grain seed will not be required. The intent of using cereal grains as temporary erosion control is to permit the Subcontractor to quickly seed potential areas as the need arises with on-site personnel and equipment.

E. Rough grading: Prior to temporary seeding and fertilizing, rough grade areas to be seeded in general and conformance to the proposed finished grades. Break up and remove large dirt clods and remove debris.

F. Trench dewatering discharge shall be directed towards sediment basins.

3.02 FENCE SUPPORTS

A. The erosion control fence shall be supported on posts at least 5’ in length on 5’ centers. The fabric shall be installed in a backfilled trench 6” deep and securely attached to the posts by any method approved by the Construction Coordinator.

3.03 PLACEMENT

A. Erosion control fencing and bales shall be placed as shown on the plans, or as directed by the Construction Coordinator.

3.04 DITCH CHECK INSTALLATION

A. Ditch checks shall be constructed by the placement of straw wattles at intervals of not greater than 200’ along ditch lines, or as shown on the plans or directed by the Construction Coordinator.

3.05 MAINTENANCE

A. The temporary erosion control systems installed by the Subcontractor shall be properly maintained as indicated in the project specific SWPPP to control erosion and siltation at all times during the life of the contract. If the Subcontractor fails to maintain the temporary erosion control systems as directed by the Construction Coordinator, the Construction Coordinator may, at the expiration of a period of 48 hours, after having given the Subcontractor written notice, proceed to maintain the systems as deemed necessary, and the cost thereof shall be deducted from any compensation due, or which may become due to the Subcontractor under this contract.

B. Sediment deposits shall be removed from the silt fence when deposits reach a maximum of 1/3 the height of the fence. Sediment shall be removed from sediment traps and diversion ditches when deposits reach approximately 1/2 the capacity of the erosion control device.

3.06 ACCEPTANCE

A. The Subcontractor shall be responsible for all vegetation until the area reaches 80 percent coverage.

B. The Construction Coordinator shall relieve the subcontractors of responsibility in writing.

3.07 REMOVAL

A. The Subcontractor shall remove temporary erosion control structures when advised to do so by the Construction Coordinator. Ditch checks shall be removed when turf in drainage swales is established as shown in the plans.

The areas where erosion control measures are removed shall be seeded and mulched per seeding and mulching specifications herein. The costs associated with the removals shall be incidental to this item.

END OF SECTION 02370

SECTION 02500 - ROADWAYS

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Hot-mix asphalt pavement construction for service drives and aggregate hard stand as indicated on the drawings.

B. Portland cement concrete construction for curb and sidewalk as indicated on the drawings.

1.02 RELATED SECTIONS

A. Section 02220 – Excavating for Structures and Pavements.

B. Section 02221 - Backfilling and Compacting for Structures and Pavements.

C. Section 02930 – Fertilizing and Seeding.

1.03 REFERENCES STANDARDS

A. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction in Illinois, latest edition.

1.04 QUALITY ASSURANCE

A. Testing and inspection shall be provided by an independent testing firm selected by the Subcontractor and approved by the Construction Coordinator. The testing laboratory shall test all materials submitted for testing by Subcontractor prior to incorporation into the work. Twenty-four (24) hour notice shall be given to the testing laboratory and Construction Coordinator before paving.

1.05 SUBMITTALS

A. Materials List:

1. Submit required number of copies identifying types and sources of materials proposed for this work.

B. Material Samples:

1. Submit materials for laboratory testing.

PART 2. PRODUCTS AND MATERIALS

2.01 GEOTEXTILE FABRIC

A. Geotextile fabric shall be as specified in Section 210 of IDOT Standard Specifications.

2.02 AGGREGATE BASE COURSE

A. For areas requiring bituminous concrete pavement, base course shall be crushed limestone Type A, Gradation CA-6 or CA-10; Section 1004 of IDOT Standard Specifications. All material shall be crushed stone and shall be placed to the thickness shown on the plans.

B. For areas requiring aggregate hardstand, a sub-base course shall be Type A, Gradation CA-1; Section 1004 of IDOT Standard Specifications. All material shall be crushed stone and shall be placed to the thickness shown on the plans.

2.03 HOT-MIX ASPHALT BINDER AND SURFACE COURSES

A. Section 406 of IDOT Standard Specifications shall govern. Surface course shall be IL-9.5L. Binder course shall be IL-19.0L.

B. Bituminous mix design shall be approved by the Fermilab Construction Coordinator prior to application.

2.04 BITUMINOUS MATERIAL

A. Prime coat (aggregate): MC-30

B. Tack coat (bituminous/concrete): SS-1, SS-1h, CSS-1, CSS-1h, RC-70, SS-1hP, CSS-1hP

PART 3. EXECUTION

3.01 INSPECTION

A. Inspect all areas and conditions where asphalt concrete paving and bituminous surface are to be placed. Notify the Construction Coordinator in writing of conditions detrimental to proper and timely completion of work.

3.02 AGGREGATE BASE COURSE

A. Work includes complete construction of base course indicated on Drawings and typical sections for proposed access roadways.

B. Construct aggregate base course to thickness shown on the plans in accordance with Section 351 of IDOT Standard Specifications.

C. Aggregate base shall be compacted to not less than 95% of the maximum dry density, as determined by the Standard Proctor Test ASTM D698. A sample of the material shall be provided to the testing laboratory and Construction Coordinator by the Subcontractor fifteen (15) days prior to its use, so that the testing laboratory can test the gradation and quality of the material.

3.03 HOT-MIX ASPHALT BINDER AND SURFACE COURSES

A. Construct hot-mix asphalt binder course and surface course to thickness shown on the plans in accordance with Section 406 of IDOT Standard Specifications.

B. Work includes complete construction of courses on prepared base course indicated on drawings and typical sections for proposed service drives.

3.04 BITUMINOUS PRIME AND TACK COAT

A. Apply bituminous materials (prime and tack coats) on aggregate base course and between bituminous courses in accordance with Sections 358, 406 and 1009 of the IDOT Standard Specifications.

B. Prime coat shall be applied to the aggregate base course at the rate of 0.50 gal./sq.yd. or as directed by the Fermilab Construction Coordinator.

C. Tack coat shall be applied between bituminous courses at the rate of 0.10 gal./sq.yd. or as directed by the Fermilab Construction Coordinator.

END OF SECTION 02500.

SECTION 02510 - UTILITIES

PART 1. GENERAL

1.01 SECTION INCLUDES:

A. Requirements to furnish and install buried industrial cooling water (ICW) piping, domestic water service (DWS) piping, chilled water service (CHWS) piping, chilled water return (CHWR) piping, natural gas (G) piping, sanitary sewer gravity piping and storm sewer piping.

1.02 RELATED SECTIONS:

A. Section 02100 – Site Preparation.

B. Section 02220 – Excavating for Structures, Utilities and Pavements.

C. Section 02221 – Backfilling and Compacting for Structures, Utilities and Pavements.

1.03 REFERENCE TO STANDARDS

A. American National Standards Institute/American Society for Testing and Materials (ANSI/ASTM):

1. ASTM D618 –Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

2. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.

3. ASTM D2837 – Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

4. ASTM D3139 – Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

5. ASTM D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

6. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

7. ASTM F477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

8. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Outside Diameter.

9. ASTM D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

10. ASTM D3034 – Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

B. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, latest edition.

C. Standard Specifications for Water & Sewer Main Construction in Illinois, latest edition.

D. Occupational Safety and Health Administration (OSHA): Current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.

E. ASME – Boiler and Pressure Vessel Code.

F. BOCA Mechanical Code, latest edition.

G. Illinois Plumbing Code, latest edition.

H. National Fire Protection Association (NFPA).

I. Plastic Pipe Institute Guidelines.

J. KAmerican Water Works Association (AWWA):

1. C104/ANSI A21.4-95 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

2. C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

3. C151/A21.53 Standard for Ductile Iron Pipe, Centrifugally Cast for Water or Other Liquids

K. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO M252 Corrugated Polyethylene Drainage Pipe

2. AASHTO M294 Corrugated Polyethylene Pipe, 12 to 48” Diameter

1.04 SUBMITTALS

A. Submit under the direction of Fermilab Construction Coordinator.

B. The following specific information shall be provided by the Subcontractor:

1. The piping shop drawings shall be new drawings prepared by the Subcontractor, not a mark-up of contract drawings, and the shop drawings shall have a bill of material on each drawing defining all items mentioned above. Locations and design details of all mechanical joints (using Flanges or Mechanical Joint (MJ) adapters) and restraint anchors of polyethylene pipe shall be shown on the shop drawings. All catalog and descriptive data shall note where the specific item is to be installed and a cross reference made on the piping shop drawings.

2. Submit certification that the manufacturer meets the applicable manufacturer's qualifications stated in this section.

3. Material lists and certifications of all piping materials which are proposed for installation on this project.

4. Manufacturer's procedures and guidelines for fusion of polyethylene pipe. Procedures shall satisfy the requirements of CFR Title 49, Part 192 Subpart F – Joining of Materials Other Than By Welding and shall contain the following:

5. Written joining procedures.

6. Pictorial presentation indicating the acceptable appearance of a completed joint.

7. List of Subcontractor's qualified persons performing heat fusion joints.

8. List of Subcontractor's qualified persons inspecting heat fusion joints.

9. Installation Manual outlining guidelines for handling, joining, installing, embedding and testing of polyethylene pipeline.

10. Product Data: Manufacturer's technical product data, including rated capacities of selected models indicated, furnished specialties and accessories, and installation instructions.

11. Pressure test results.

12. Material Safety Data sheets for cleaning and disinfecting solutions.

1.05 QUALITY ASSURANCE

A. Manufacturer:

1. As a basis for acceptance of the product, the Manufacturer shall furnish a certificate of conformance to the specifications.

2. To the greatest extent possible obtain materials from only one Manufacturer, even though several may be specified as acceptable Manufacturers.

B. Supplier: Subcontractor shall obtain the materials only from a recognized material supplier who has been furnishing materials in the same area as project for a period of not less than two (2) years.

C. Installer: Subcontract installation of materials to a company specializing in the installation in performing work of this section with a minimum five (5) years experience. Assign work to experienced tradesmen in compliance with trade union jurisdictions. Subcontractor and its qualified persons installing polyethylene pipe MUST also provide evidence of prior experience of installation of a minimum of 10,000 lin. ft of pipe for similar applications described above.

D. Installation:

1. Perform work in accordance with state and local building codes.

2. Perform work in accordance with industry standards.

1.06 WARRANTY: Materials and workmanship shall have a one-year warranty to be free from defects in workmanship and materials. The warranty will be from the date of completion of construction.

PART 2. PRODUCTS

2.01 MATERIALS

A. High Density Polyethylene (HDPE) Pipe shall be used for all new buried Industrial Cooling Water (ICW), Gas line piping extended from existing utility lines or from new building structures. HDPE Pipe shall be used for all new buried Domestic Water Service (DWS), Chilled Water Service (CHWS) and Chilled Water Return (CHWR) extended from existing utility lines or from new building structures.

1. Extra High Molecular Weight (EHMW) high-density polyethylene resin having an ASTM D 3350 cell classification of 345444C, Grade PE34 material, a PPI material designation PE 3408 and having a long-term hydrostatic strength of 1600 psi at 73°F and 800 psi at 140°F when tested in accordance with ASTM D2837.

2. ICW piping and fittings shall be FM approved and shall be Plexco RED STRIPE PE 3408 or FM approved equal with a wall thickness designed to meet Class 150 service pressure ratings.

3. DWS piping and fittings shall be Plexco BLUE STRIPE PE 3408 or approved equal with a wall thickness designed to meet Class 150 service pressure ratings.

4. CHWS/CHWR piping and fittings shall be Plexco PURPLE STRIPE PE 3408 or approved equal with a wall thickness designed to meet Class 150 service pressure ratings.

5. Gas piping and fittings shall be Plexco YELLOW STRIPE PE 3408 SDR 11 or approved equal.

6. All HDPE pipes shall be manufactured in full compliance with ASTM F714.

7. Ductile Iron Fittings: Ductile iron fittings to be used with HDPE piping shall be compact style fittings meeting the requirements of ANSI/AWWA C153/A21.53.

8. Transition Fittings: For transition from ductile iron pipe to polyethylene pipe, appropriate flanged transition fittings or self-restrained mechanical joint adapters and gaskets approved by the manufacturer of the polyethylene pipe shall be used. FM approved flange adapters shall be used to connect ICW polyethylene piping to ductile iron. Stainless steel inserts are required to be used to stiffen the polyethylene pipe at all mechanical joints. All MJ connections to HDPE pipe shall be restrained joints with MEGA-LUG pipe joint restraint fittings.

9. The mechanical joint restraint device shall have a working pressure of 250 psig and a minimum safety factor of 2:1.

B. Polyvinyl Chloride (PVC) Pipe shall be used for all new buried underground Sanitary Sewer Pipe (gravity) extended from exiting utility lines or from new building structures. PVC Pipe may be used for DWS Pipe, CHWS Pipe and CHWR Pipe extended from existing utility lines or from new building structures.

1. PVC pipes and couplings shall be made of unplasticized PVC compounds having a minimum cell classification of 12454-B, as defined in ASTM D1784. The compound shall qualify for a Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4 degree Fahrenheit, in accordance with the requirements of ASTM D2837.

2. DWS piping and couplings shall be PVC C900 with a water pressure rating of 150 psi and shall conform to AWWA C900 and shall be DR18 with push-on joints with rubber gaskets meeting ASTM F477.

3. CHWS/CHWR piping and couplings shall be PVC C900 with a water pressure rating of 150 psi and shall conform to AWWA C900 and shall be DR18 with push-on joints with rubber gaskets meeting ASTM F477.

4. DWS, CHWS and CHWR Pipes shall be blue. Sanitary Sewer Pipes shall be green. DR rating and pipe classification shall be stamped on pipe.

5. Gravity Sanitary Sewer pipes shall be PVC pipes conforming to ASTM D3034 with solvent weld or elastomeric joints. Pipes shall be SDR 26 unless otherwise noted on the drawings. PVC fitting joint type and SDR shall be same as the pipe that the fitting is connected to.

C. Corrugated HDPE Pipe shall be used for all new Storm Sewer Pipe extended from existing structures or from new structures unless otherwise noted. Pipes shall conform to ASTM D3350 for PE 3408 material with cell classification of 335434C or better. Pipe shall be DR 17, unless otherwise noted. Joints shall be thermal butt fusion in accordance with manufacturer's recommendation.

D. Gate Valves: Resilient wedge, iron body gate valve, counter clockwise opening, non-rising stem, inside screw for underground. Gate valves shall have 175-lb. rating with mechanical joint connections and flanges suitable for use with yard box or indicator post. Waterous Co. Series 2500 or Fermilab approved equal. Valves for ICW line shall comply with NFPA 24, as listed by Underwriters Laboratories and approved by Factory Mutual for fire protection. All bolts that will be exposed to earth shall be stainless steel. Each valve shall be protected with 1 magnesium anode or as directed.

E. Valve Box: Tyler Valve Box, Model 664-S with stem for gate valve.

F. Indicator Posts: UL 789, FM Approved, vertical type, cast iron body with operation wrench, and adjustable cast iron barrel of length required for depth of burial valve. Waterous Post Indicator Valve IP-71 or Fermilab approved equal.

G. Cathodic Protection: Cathodic protection shall be provided in the form of magnesium anodes. Anodes are required to achieve minus 850 millivolts "instant off" potential on the metallic area and at the same time not provide overvoltage above 1150 millivolts "instant off". As a minimum, the magnesium anode unpackaged weight shall be 17 pounds. Lead wires shall be number 12 solid copper, 10 feet long, Type HMWPE (high molecular weight polyethylene) insulation, ASTM D1248, Type 1, Class C, Category 5, Grade E5.

H. Catch Basins: Round catch basins shall be 60" inside diameter unless otherwise shown on plans or required.

1. Submit manufacturer's preproduction (shop) drawings for approval prior to the start of manufacturing.

2. Subcontractor shall carefully locate all pipe locations, sizes, orientations and elevations prior to ordering catch basins.

3. Round catch basins shall meet the requirements of ASTM C478.

4. Precast wall thickness shall be a minimum of 6" or as shown on the plans.

5. Provide 6" thick pre-cast catch basin base. Catch basin bottom section may be pre-cast with integral base.

6. Catch basins shall be provided with pre-cast reinforced concrete in-bell cover designed to accommodate AASHTO H20 loading. In-bell cover shall be provided with 24" opening for casting.

7. Catch basins requiring separate base and riser sections must be provided with standard pipe tongue and groove joints.

8. Seal joints watertight with prefabricated rubber or plastic gaskets or formed in place butyl rubber seal.

9. Joint sealers shall be butyl rope caulk or approved equal.

10. Provide custom knock-outs/cut-outs based on project and location specific conditions.

11. A minimum of 2” of the pre-cast structure is required between the top of a knock-out/cut-out and the top of the structure. A minimum of 2” of pre-cast structure is required between the side of a knock-out/cut-out and the inside face of an adjacent sidewall.

12. Fiber-reinforced pre-cast concrete adjusting rings meeting the requirements of ASTM C478. Provide rings of 2” or 4” thickness.

13. Precompressed butyl gasket, 3/8”x3 ½” shall be used between the top of the catch basin and first adjustment ring, and between all subsequent rings. Butyl material shall be E-Z Stick or equal.

2.02 IDENTIFICATION AND MARKING

A. All polyethylene pipe materials shall be identified along its length by the designated striping color or color coded print line that repeats every 2 ft-0 in. The printline shall state the manufacturer, product trade name, material, size and dimension ratio, pressure class, manufacturing standard, NSF or FM approval logo where applicable, production lot code, and manufacturing date.

B. Permanent identification of polyethylene piping service shall be provided by a permanent color coding system such as colored pipe, co-extruding longitudinal stripes into the pipes outside surface of the pipe or other permanent means as approved by Fermilab.

1. ICW service piping shall be red striped or red print line.

2. DWS service piping shall be blue striped or blue print line.

3. CHWS and CHWR service piping shall be purple striped or purple print line.

4. Gas service piping shall be yellow striped or yellow print line.

5. Sanitary piping shall be green striped or green print line.

C. Marking and Delivery – Each standard and random length of pipe in compliance with this specification shall be clearly marked with the following information:

1. Pipe Size

2. Pipe Class

3. Production Code

4. Material Designation

2.03 FABRICATION AND MANUFACTURE

A. Polyethylene ICW and DWS pipe shall be manufactured to ductile iron sizes. Polyethylene Natural Gas pipe shall be manufactured to iron pipe sizes.

2.04 SHIPPING AND HANDLING

A. Fittings and accessories shall be packaged in cartons or crates and secured to and shipped on wood pallets.

B. Pipe shall be handled using fabric slings. Do not use chains or wire rope slings.

C. At the site of installation, inspect each length of pipe and each component visually to ensure that it has not sustained any determinable damage that could impair its serviceability. Reject or repair all damaged materials determined unsuitable for installation.

D. Use care in loading and handling all material. Cover or house properly all materials and equipment requiring protection from the weather. Handle all pipes with end hooks or slings in a manner so as not to damage the coatings or the beveled ends of the pipe. When storing pipe or stringing it along the job, use skids or pads, as necessary, to prevent damage to the pipe or coating.

PART 3. EXECUTION

3.01 GENERAL

A. Care shall be taken during unloading and handling to prevent damage to the pipe. Never roll pipe off of the truck.

B. Proper and suitable tools and appliances for the safe and convenient handling and placing of the pipes shall be used. All pieces shall be carefully examined for defects and no piece shall be laid which is known to be defective. If any defective piece should be discovered after having been laid, it shall be removed and replaced with a sound piece, in a satisfactory manner, by the Subcontractor at his own expense.

C. The pipes shall be thoroughly cleaned before they are placed, shall be kept clean until they are accepted in the completed work, and when laid shall conform accurately to the lines and elevations provided by Fermilab, or as specified and shown on the drawings.

D. Install in accordance with the Manufacturer's instructions, all state and local codes and as described herein and shown on the drawings. ICW piping shall

be installed to meet the requirements of NFPA 24 as a minimum. Install non-conducting dielectric connections wherever jointing dissimilar metals

3.02 INSTALLATION OF BURIED PIPE LINES

A. General: The Subcontractor shall furnish and install the buried pipelines as shown on the drawings and specified herein. All buried pipe shall be uniformly sloped and installed at the proper inverts where slopes and centerline elevations are shown on the drawings. If a grade conflict (with other pipes) exists, the Subcontractor shall propose a resolution to the conflict in writing to the Fermilab Construction Coordinator for acceptance prior to installation.

B. Pipe Cleaning During Installing Operation: Should the pipe ends become dirty or dusty during the storage of the pipe, a thorough cleaning of the pipe shall be done just before the pipe is installed. At this time, a visual check shall be made by placing the pipe in an inclined position to assure that all foreign material and dirt is removed from the inside of the pipe. The pipe shall be kept clean during and after installation. At the termination of pipe installation, the open end of the pipeline shall be closed off by a suitable cover until installation operations are resumed.

C. Depth of Pipe Cover: All pipes shall be laid to minimum depth as indicated on the drawings from the existing ground surface or established grade to the top of the barrels of the pipe. No case shall buried water piping be less than 5.5’.

D. All buried pipe lines shall be installed per manufacturer’s recommendations and as instructed by Fermilab Construction Coordinator.

3.03 POLYETHYLENE PIPE CONNECTIONS

A. Protective sleeves shall be installed at all transition fittings.

B. Branch connections to the main shall be made with molded tees and not with saddle fittings.

C. HDPE anchor restraints shall be provided at every transition to different piping material. All MJ connections to HDPE pipe shall be restrained joints with MEGA-LUG pipe joint restraint fittings. Joints between MJ pipe and HDPE pipe shall have stainless steel pipe stiffener inserts in the HDPE pipe ends. Thrust blocks shall be provided at changes of pipe direction, branches, and at ends of underground pressure pipe .External joint restraints shall not be used in lieu of fully restrained mechanical couplings.

D. Flange/MJ Adapter Installation: Flanges/MJ adapters shall be attached to pipe and fittings using butt fusion. The flanges/MJ adapters shall be aligned and centered relative to the pipe. Flanges/MJ adapters should be square with the valve or other flange before tightening of bolts. Bolts should not be used to draw flanges into alignment. Bolt threads shall be lubricated, and flat washers shall be used under flange nuts. Bolts shall be tightened using a “star tightening pattern.” See manufacturer’s recommendations. Twenty-four hours after first tightening the flange bolts, they must be re-tightened using

the same “star tightening” pattern used above. The final tightening torque shall be as indicated by the manufacturer. The polyethylene pipe trench shall be backfilled up to the anchor restraint location for at least twenty-four (24) hours before installation of the anchor restraint and the mechanical joints.

E. Polyethylene pipe joints shall be made with butt type utilizing the heat fusion process in strict accordance with the pipe manufacturer’s instructions, the AGA Plastic Pipe Manual, the Plastic Pipe Institute Guidelines, and local and state requirements. Threaded or flare type fittings are not allowed:

1. All fusion joints shall be made by properly trained personnel, whose competency has been determined by adequate testing.

2. On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, then fusion test straps shall be cut out. Test straps shall be a minimum 12” or thirty (30) times the wall thickness in length and 1” or 1.5 times the wall thickness in width:

a. The test strap shall be bent until the ends of the strap touch. If the fusion fails at the joint, a new trial fusion shall be made, cooled and tested.

b. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.

3. All surfaces of the fusion tools, pipe and fittings shall be cleaned and free of contaminants prior to use using all cotton rags.

4. A heating iron temperature of 500°F shall be used for saddle and socket fusion.

5. A heating iron temperature of 440°F shall be used for butt fusion.

6. Any questionable joints shall be cut out and fused again.

F. Subcontractor’s qualified inspector shall visually inspect all joints.

3.04 CONNECTION TO EXISTING ICW LINES

A. Inform Fermilab at least forty-eight (48) hours in advance of connecting to the existing water system.

B. If an interruption is required, coordinate with the Fermilab Construction Coordinator. Only after assurance from the Fermilab Construction Coordinator that all appropriate valves are off and the area of pipe to be worked on is completely isolated, and that alternate fire protection procedures are in effect, can actual interruption of the line occur.

C. Excavation to initially expose the existing piping shall be accomplished by hand digging.

D. Asphaltic coating on the exterior of existing piping which has been damaged by work or cleaning of pipe surface shall be patched with new, brushed asphaltic coating.

E. All foreign substances and material blockage must be removed from the interior of any piping before piping is installed.

3.05 HYDRANTS AND VALVES

A. Install all valves in accordance with NFPA 24, manufacturer's installation manual and applicable codes.

3.06 DISINFECTION OF WATER MAINS:

A. Before each system is accepted by Fermilab for their operation, perform the service and work hereinafter specified under this heading, which shall include but not be limited to, all labor, materials, chemicals, temporary pumps, piping and connections.

B. Sections of pipe to be disinfected shall be flushed to remove any solids or contaminated materials that may become lodged in the pipe.

C. All new mains, repaired portions or extensions shall be chlorinated so that the initial chlorine residual is not less than 50 mg/L and that a chlorine residual of not less than 25 mg/L remain in the water after standing 24 hour in the pipe.

D. Perform all work according to AWWA Standard C651 and Standard Specification for Water and Sewer Construction in Illinois.

E. Subcontractor shall be responsible for all sampling and testing by a laboratory certified by the Department of Health.

3.07 CLEANING AND FLUSHING OF ICW PIPING SYSTEM:

A. Before each system is accepted by Fermilab for their operation, perform the service and work hereinafter specified under this heading, which shall include but not be limited to, all labor, materials, chemicals, temporary pumps, piping and connections.

B. All ICW piping shall be thoroughly and completely flushed out with industrial cold water to remove any foreign matter that can be removed by flushing.

3.08 DISPOSAL OF CLEANING AND FLUSHING WATER

A. All water used for cleaning, flushing and disinfection shall be collected and disposed of by the Subcontractor in accordance with the requirements of the Fermilab Construction Coordinator.

3.09 HYDROSTATIC LEAK TESTING:

A. All new piping shall be subjected to hydrostatic leak tests following construction of the entire line. Hydrostatic test shall follow the procedures of

the PPI Technical Report #31 and the requirements specified herein. The ICW hydrostatic leak test shall also conform to the requirements of NFPA 24.

B. Tests shall be performed in the presence of the Fermilab Construction Coordinator. Notify Fermilab forty-eight (48) hours in advance of the tests to be conducted.

C. Tests shall occur before any mechanical joints of polyethylene pipe are concealed.

D. Subcontractor shall be responsible for designing and installing temporary bulkheads, anchors, bracing, corporation stops and piping etc. as required to safely carry out pressure testing of the pipeline. The pipe may be buried at intervals to hold it in place during testing but all joints and connections shall be exposed during testing.

E. The required test pressure shall the ICW line shall be 160 psig and for the SD lines shall be 110 psig.

F. The initial expansion phase of the test shall pressurize the test section of pipe to the required test pressure, and enough make-up liquid added each hour for three (3) hours to return to test pressure and the start of the test phase.

G. The test phase shall last for three (3) hours. At the end of the test time, the test section is returned to test pressure by adding and measuring make-up water.

H. Slight pressure drop will occur due to continued expansion of the pipe during the test. The amount of makeup water shall be measured with the allowable amount of makeup water as shown in Table 16 of PPI Technical Report TR #31. If the test pressure is not returned within the allowable volume of water, the test fails. If there are no visual leaks or significant pressure drops during the final test phase, the pipeline passes the test.

I. After testing, blow down the completed sections in order to remove dirt, rust, etc. In general, blow down from a previously cleaned section through the section to be cleaned.

3.10 TEST REPORTS:

A. All tests of ICW and SD systems shall be reported on properly filled out and signed forms. “Contractor’s Material & Test Certificate for Private Fire Service Mains” as provided in NFPA 24.

B. Six (6) copies of the test reports shall be submitted to Fermilab for evaluation and record use. Test reports shall include complete test data showing conditions, leakage rates and measurements as required above.

3.11 TESTING

A. Prior to acceptance and initial operation, all piping installation shall be inspected and tested to determine that the materials, design, fabrication and

installation practices comply with the applicable requirements of AWWA. Hydrostatic Test: Each length of pipe shall be tested to four times the design pressure of the pipe for a minimum of five (5) seconds. The integral bell shall be tested with the pipe.

B. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Prior to testing, the interior of the pipe shall be cleaned of all foreign material.

3.12 PRECAST CONCRETE MANHOLE/CATCH BASIN INSTALLATION

A. The Subcontractor shall pour a concrete base slab or place a precast slab below the piping assembly to support the precast manhole sections and the pipe support bench.

B. The precast manhole sections shall be connected and sealed using a butyl joint sealant in rope form or rubber gasket “O” rings conforming to ASTM C443.

C. Field cut slotted wall openings in the bottom riser section to accommodate the pipe penetrations. Openings shall be flare cuts with the outside wall opening larger than the inside wall opening. Opening shall be approximately 1’-2” larger than the pipe OD.

D. The pipe penetrations shall be grouted in place using a non-shrink cementitious grout.

E. Grade rings and/or bricks and mortar shall be used for supporting the manhole cover and frame. Adjustments to final grade elevation shall be made by using grade rings, brick, grout or a combination of all three.

F. Frame casting shall be set in full mortar beds. Cement grout collars shall be placed around the casting after the final setting.

3.13 GENERAL REQUIREMENTS FOR GRAVITY LINE TESTS

A. Make tests in the presence of the Fermilab Construction Coordinator.

B. Test the entire length of the sewer by the methods described below.

C. Divide the sewer into subsections not exceeding 1200 feet, except where entire system is 1200’ or less in total length.

D. Seal off the sewer and subsections to be tested by inserting inflatable rubber bags in the pipe or by other approved means.

E. Plug all wyes, tees and stubs with readily removable flexible jointed caps or other approved means.

F. Allowable Leakage Rate: Leakage shall not exceed 1.9 gallons per inch of pipe diameter per 100 foot length of pipe in 24 hours.

G. If leakage exceeds the allowable rate, repair the work and repeat the test until a satisfactory test is obtained.

H. All flexible pipes shall be tested for excess deflecting. The total deflection shall not exceed manufacturer's recommended deflection limits or a maximum of 5.0% of the internal diameter of the pipe, whichever is more stringent.

I. All testing of pipes and manholes shall conform to procedures outlined in the Standard Specifications for Water and Sewer Construction in Illinois, current edition.

3.14 CATHODIC PROTECTION – Magnesium Anode Installation

A. Valves and hydrants shall be protected with a magnesium anode. Valves and hydrants interconnected with ductile iron pipe shall have individual anodes installed.

B. Install anodes in a dry condition after plastic or waterproof protective covering has been completely removed from water-permeable, permanent container housing the anode metal. Do not use anode-connecting wire for lowering anode into hole. Backfill annular space around anode with fine earth in 6” (150 mm) layers; compact each layer using hand tools. Do not strike anode or connecting wire during compacting. After backfilling and compacting to within 6” (150 mm) of finished grade, pour approximately 5 gal. (20 L) of water into each filled hole. After water has been absorbed by earth, complete backfilling to finished level.

C. Cover trench bottom for the anode wire with 3” (76 mm) layer of sand or stone-free earth. Center wire on backfill layer and do not stretch or kink the conductor. Place backfill over wire in layers not exceeding 6 inches (150 mm) in depth, and compact each layer. Use clean fill, free from tree roots, wood scraps, vegetable matter and refuse. Place cable warning tape within 18 inches (460 mm) of finished grade, above cable and conduit.

D. If rock strata is encountered before achieving specified augured hole depth, install anodes horizontally at depth at least as deep as bottom of pipe to be protected.

E. Install anodes spaced as indicated, directly connected to the metallic fitting, allowing adequate slack in connecting wire to compensate for movement during backfill operation.

END OF SECTION 02510

SECTION 02920 - TOPSOIL

PART 1. GENERAL

1.01 SECTION INCLUDES

A. All material, labor, and equipment to place topsoil on the open and disturbed areas of the site, to the lines and grades shown.

1.02 RELATED SECTIONS

A. Section 02220 – Excavating for Structures and Pavements.

B. Section 02221 – Backfilling and Compacting for Structures and Pavements.

C. Section 02500 – Roadways.

1.03 REFERENCE TO STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO).

B. American Society for Testing and Materials (ASTM).

C. Illinois Department of Transportation (IDOT); Standard Specifications for Road and Bridge Construction in Illinois, latest edition

1.04 SUBMITTALS

Representative samples of material proposed for use as topsoil, including test results on clay, sand, and organic contents and pH, shall be submitted to the Construction Coordinator for approval prior to placement of the material.

PART 2. PRODUCTS AND MATERIALS

2.01 TOPSOIL

A. Topsoil shall be defined as follows:

B. Topsoil shall be free from large roots, sticks, weeds, brush, or stones larger than 1 in. in diameter or other litter and waste products. It shall be a loamy mixture having at least 90 percent passing the No. 10 sieve. It shall be free from extraneous materials and shall comply with the following requirements:

C. It shall contain not less than 1 percent or more than 10 percent organic matter as determined by the test for organic matter in accordance with AASHTO T 194.

D. It shall contain not less than 12 percent or more than 50 percent clay as determined in accordance with AASHTO T 88.

E. The sand content shall not exceed 55 percent as determined in accordance with AASHTO T 88.

F. The pH of the sample shall not be lower than 5.0 nor higher than 8.0. The pH shall be determined with an acceptable pH meter on that portion of the sample passing the No. 10 sieve, in accordance with the “Suggested Methods of Tests for Hydrogen Ion Concentration (pH) of Soils” included in the procedures for Testing Soils issued December, 1964 by the American Society for Testing and Materials.

PART 3. EXECUTION

3.01 PLACEMENT

A. General Turf Areas:

1. Under this item, grading will be necessary only at those areas where placement of topsoil will inhibit drainage. At those areas, sufficient material shall be removed to allow topsoil placement without inhibiting the drainage. Placement of the topsoil shall not begin until the Construction Coordinator approves the lines, grades, and condition of the subgrade. If the existing surface has become hardened or crusted, it shall be disked or raked or otherwise broken so as to provide a bond with the layer of topsoil to be applied.

2. The finished surface shall be free of clods, rocks and shall conform to the lines and grades shown on the plans. No “ponding” will be allowed.

3.02 LIMITS

A. 6” of topsoil shall be placed on all areas on the site not being paved unless otherwise noted.

B. Topsoil shall be graded to be level with the edge of the paved surface and sloped away from the paved surface.

C. It is not anticipated that topsoil from off-site will be required.

END OF SECTION 02920

SECTION 02930 - FERTILIZING AND SEEDING

PART 1.GENERAL

1.01 SECTION INCLUDES

A. All work necessary to fine grade the site to drain as shown and bring the surface to a uniform plane, to fertilize and prepare the soil for seeding, and to seed the site as specified herein.

1.02 RELATED SECTION

A. Section 02220 - Excavating for Structures and Pavements.

B. Section 02221 - Backfilling and Compacting for Structures and Pavements.

C. Section 02370 – Erosion Control

D. Section 02500 – Roadways.

E. Section 02920 – Topsoil.

1.03 REFERENCE TO STANDARDS

A. Illinois Department of Transportation (IDOT); Standard Specifications for Road

B. And Bridge Construction in Illinois, latest edition.

C. Illinois Urban Manual

1.04 QUALITY ASSURANCE

A. The work under this section shall be done by Subcontractor regularly engaged in the landscape business as it pertains to grading, fertilizing and seeding. The work in this section involves planting seeding mixture. This work shall be done by Subcontractor knowledgeable of seeding mixture and its application.

1.05 SUBMITTALS

A. The Subcontractor shall submit his plan for executing the work included herein. This submittal shall include fertilizer to be used, information on the type of each seed variety, etc.

1.06 WARRANTY

A. The seeding Subcontractor shall be responsible for the satisfactory growth of grass and forbs species on all areas seeded until final acceptance of the seeding work.

PART 2.PRODUCTS AND MATERIALS

2.01 SEED MIXTURES for Land Management Areas, Roadsides and Slopes

A. IDOT Class 2 Roadside Mixture shall be used in all seeding applications. It consists of the following:

	Lbs. per acre
Tall Fescue (Inferno, Tarheel II, Quest, Blade Runner or Falcon IV)	100
Perennial Ryegrass	50
Creeping Red Fescue	40
Red Top	10

2.02 MATERIALS

A. All seeds shall be guaranteed by the Subcontractor to be true to name and variety. Seed mixtures shall be proportioned by seed count and seed count percentages. The seed counts and seed count percentages indicated per acre in these specifications shall mean the total amount of pure live seed per acre for all species listed except forbs.

B. At least two weeks prior to the time of seeding, the Subcontractor shall provide to the Construction Coordinator a written description of the seed mixtures showing the percentage of seeds by number of each species. This description shall also include the name and location of the seed supplier, the origin of the various species of seed, a statement of the purity of the grasses, and the estimated number of seeds per pound of each of the kinds of seed to be furnished.

C. All seeds shall have the proper stratification and scarification to break seed dormancy. All seeds shall be packed and covered in such a manner as to insure adequate protection against damage and maintain dormancy while in transit, storage, or during planting operations.

PART 3. EXECUTIONS

3.01 SEEDING LOCATIONS

A. Subcontractor shall fertilize and seed all disturbed areas within site boundaries.

3.02 SEED BED PREPARATION

A. After the areas to be seeded have been brought to the proper grades, all boulders, stones larger than one-inch in diameter, debris, and other material shall be removed. The areas shall then be tilled to a depth of at least 3 in. by disking, harrowing, or other approved method until the condition of the soil is acceptable to the Construction Coordinator. Fertilizer and agricultural limestone shall be distributed uniformly at a rate as determined by the Subcontractor to ensure proper nutrients for establishment of the native grass communities.

3.03 SEEDING METHODS

A. The seeding Subcontractor shall submit a plan and schedule for seeding to the Construction Coordinator at least two weeks prior to the scheduled commencement of the work. The plan shall include a list of the proposed equipment and methods of seeding. Prior to starting work, all seeding equipment shall be calibrated and adjusted to sow seeds at the proper seeding rate. The Construction Coordinator shall be notified at least forty-eight (48) hours prior to beginning the seeding operations. Seeding operations shall be conducted between April 1st and July 30th or between October 1st to freeze up. Written permission from Fermilab is required for any adjustment to these dates.

B. Broadcast Seeding: If a broadcast method of seeding is utilized, no seeds shall be sown during high winds or when the seedbed is not in a proper condition for seeding. Within twelve (12) hours of seeding, all seeded areas shall be rolled at right angles to the runoff with a suitable roller to compact the seedbed and place the seed in contact with the soil. Mulching of the seeded area shall be performed at the discretion of the Sub-Contractor.

C. No-till or drill seeding: If a rangeland type grass drill or a no-till planter is utilized, rolling of the seedbed is not required. Mulching shall be performed at the discretion of the Subcontractor.

D. For slopes larger than 2 percent, a knitted straw erosion control blanket shall be placed within 24 hours of seed placement. Prior to placing the blanket, the areas to be covered shall be relatively free of rocks or clods over 1-½"(40 mm) in diameter, and sticks or other foreign material which will prevent the close contact of the blanket with the seed bed. If, as a result of rain, the prepared seed bed becomes crusted or eroded, or if eroded places, ruts, or depressions exist for any reason, the Subcontractor shall rework the soil until it is smooth and reseed such areas which are reworked.

E. After the area has been properly shaped, fertilized, and seeded, the blanket shall be laid out flat, evenly, and smoothly, without stretching the material. The knitted straw blankets shall be placed so that the netting is on the top and the fibers are in contact with the soil.

3.04 SEEDING EQUIPMENT

A. Seeding equipment shall meet the following requirements:

1. Disk shall be weighted if necessary to achieve the required tillage depth.

2. Disks shall have sound, unbroken blades, and shall be in a good state of repair.

3. Rollers or cultipackers shall have rollers at least 6 in. in diameter, and shall be of sufficient weight to pulverize the clods of soil.

4. No-till planters and drills shall be specifically designed for the seeding of native grasses.

B. Any other equipment utilized by the Subcontractor shall be subject to the approval of the Construction Coordinator.

END OF SECTION 02930

SECTION 03100 - CONCRETE FORMS AND ACCESSORIES

PART 1. GENERAL

1.01 SCOPE OF WORK: Subcontractor shall furnish all labor, material, equipment, transportation, supervision and services necessary for the design and installation of permanent or temporary forms and falsework for cast-in place concrete complete with form liners, coatings, form ties, manufactured joints, anchors, inserts and waterstops as specified herein and as shown on the Subcontract drawings. The work includes, but is not necessarily limited to, the following:

A. Design of formwork.

B. Materials and fabrication of formwork.

C. Shoring, bracing, ties and anchorage of formwork.

D. Forming for openings, inserts and embedments.

E. Formwork accessories.

F. Formwork removal.

1.02 RELATED WORK: The following sections prescribe items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 03200 – Concrete Reinforcement.

B. Section 03300 – Cast-in-Place Concrete.

C. Section 05500 – Miscellaneous Metals.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision (with addenda, if any) in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. ACI (American Concrete Institute):

1. ACI 301 Specifications for Structural Concrete.

2. ACI 347 Guide to Formwork for Concrete.

B. APA (American Plywood Association):

1. "Plywood for Concrete Forming."

2. "Plywood Design Specification."

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

1. A 446 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural Quality.

2. A525 Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, General Requirements.

D. NFPA (National Forest Products Association):

1. "National Design Specification for Stress Grade Lumber and Its Fastenings."

E. SSFI (Scaffolding Shoring and Forming Institute):

1. “Recommended Horizontal Shoring Beam Erection Procedure."

2. "Recommended Safety Requirements for Shoring Concrete Formwork."

3. "Wood Structural Design Data."

1.04 SUBMITTALS: The following items shall be submitted to Fermilab for review. Review and release of submittals does not relieve Subcontractor of any of the responsibilities and requirements of this section and the design drawings. Review of the Subcontractor's plans and methods of construction shall not be construed to relieve the Subcontractor in any way of his responsibility for the successful performance of the work.

A. Manufacturer's Certificate of Compliance: Certifies that products supplied meet or exceed specified requirements.

B. Shop Drawings: Shop drawings for formwork, including all dimensions, thicknesses, openings, including construction joints contractor intends to utilize for sequencing.

C. See Exhibit A for number and manner of submittals.

1.05 QUALITY ASSURANCE AND CONTROL

A. General: Perform work according to the recommendations of ACI 347 and referenced documents.

B. Requirements:

1. Design formwork to support vertical and lateral loads as recommended in Chapter 2 of ACI 347 and that might be applied until such loads can be supported by the concrete structure and to resist forces due to placing and vibrating concrete.

2. Construct formwork so that concrete slabs, walls and other members shall be of correct dimensions, shape, alignment, elevation and position.

C. Tolerances:

1. Control points and benchmarks shall be established and maintained in an undisturbed condition until final completion and acceptance of work so that they are adequate for reference to establish tolerances.

2. The formwork shall be set and maintained so that the tolerances of the completed work shall not vary from the drawings by more than the requirements of Table 4.3.1 of ACI 301 and Chapter 3 of ACI 347.

D. Coordinate this section with other sections of work that require attachment of components to formwork.

E. Subcontractor is responsible for quality control and construction inspection in accordance with the requirements of Exhibit A.

F. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and sections shall be required.

1.06 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring and bracing to ensure that work is in accordance with formwork design; and that supports, fastenings, wedges, ties and items are secure.

B. Ensure that formwork is anchored to shores below so that movement of formwork system will be prevented during concreting.

C. During concreting, check elevations, camber and plumbness of formwork.

D. Do not reuse wood formwork more than three times for exposed concrete surfaces; do not patch formwork.

E. Check gradual irregularities with a 5’-0” template.

F. Provide positive means of adjustment (wedges or jacks) to permit realignment or readjustment of shores if settlement occurs.

1.07 PRODUCT DELIVERY AND HANDLING

A. Store formwork materials off ground.

B. Ventilate and protect to prevent deterioration from moisture.

C. Protect from dirt and grease.

D. Protect from damage.

PART 2. PRODUCTS

2.01 ALL FORMWORK shall comply with the requirements of Chapter 4 of ACI 347.

2.02 WOOD FORM MATERIALS

A. Plywood shall be Structural I C-C Ext-APA or B-B Plyform Class I Ext-APA; 5/8” minimum thickness.

B. Lumber shall be sound, free from loose knots, of uniform thickness, dressed, straight and true, without twists or bends.

C. Exposed Surfaces:

1. Use smooth faced plywood or steel forms for exposed surfaces.

2. For exposed surfaces in prominent public view, tape joints with waterproof tape to prevent bleeding and honeycombing at joints.

D. Non-exposed Surfaces:

1. Use lumber, plywood or steel forms for non-exposed surfaces.

2. Neat excavation cuts to form sides of footings below grade will be allowed when soil character permits and with prior approval of the Fermilab Construction Coordinator:

a) Hand trim sides and bottom of earth forms. Remove loose soil before placing concrete.

b) When using earth forms, provide additional concrete beyond the minimum design dimensions to the side of the earth cut at no additional cost.

2.03 STEEL FORMS shall be galvanized and minimum 16 gauge matched, tight-fitting and stiffened to support weight of wet concrete plus construction loads without deflection detrimental to tolerances and appearance of finished surfaces.

2.04 FORMWORK ACCESSORIES

A. Form ties shall be snap-off type, metal, minimum 3,000 pound capacity, fixed length, 1” back break dimension and free from defects that could leave holes larger than 7/8” diameter in concrete surface.

B. Form release oil shall be colorless mineral oil that will not stain concrete or absorb moisture.

C. Corners shall be chamfered, rigid plastic, rubber (neoprene) or wood type; 3/4” x 3/4” in size; and maximum possible lengths.

D. Nails, spikes, lag bolts, through bolts and anchorages shall be sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

PART 3. EXECUTION

3.01 GENERAL

A. Examine the substrate, formwork and the conditions under which formwork is to be placed. Do not place formwork until the Fermilab Construction Coordinator has approved the sub-grade preparation.

B. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

C. Provide chamfer strips on external corners of beams, girders and columns unless shown otherwise on drawings.

D. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to over stressing by construction loads.

E. Erect formwork, shoring and bracing to the exact sizes, shapes, lines and dimensions shown and as required to obtain accurate alignments, location, grades, level and plumbness in the finished structure.

3.02 FORM RELEASE OIL

A. Apply form release agent on formwork in accordance with manufacturer's recommendations; wipe off excess form release agent to leave surface of forms just oily to the touch.

B. Apply oil before placing reinforcing steel, anchoring devices and embedded items.

C. Do not apply form release agent wherever concrete surfaces will receive special finishes or wherever applied coverings are affected by agent; soak inside surfaces of untreated forms with clean water; keep surfaces coated before placing concrete.

3.03 INSERTS, EMBEDDED ITEMS AND OPENINGS

A. Provide formed openings wherever required for items to be embedded in or passing through concrete work.

B. Locate and set in place items that will be cast directly into concrete.

C. Coordinate work of other sections in forming and placing openings, slots, reglets, recesses, chases, sleeves, bolts, anchors and other inserts.

D. Install accessories in accordance with manufacturer's instructions, to lines and elevations shown on drawings; ensure items are not disturbed during concrete placement.

3.04 REMOVAL OF FORMS

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and the imposed construction and live loads. Time of form removal shall follow the guidelines of ACI 301 and ACI 347.

B. Loosen forms carefully; do not wedge pry bars, hammers or tools against finish concrete surfaces.

C. Store removed forms in such a manner that surfaces to be in contact with fresh concrete will not be damaged; discard damaged forms.

3.05 CLEAN-UP: Form Cleaning

A. Clean and remove foreign matter from forms as erection proceeds.

B. Clean debris from formed cavities before placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter; ensure that water and debris drain to exterior through clean-out ports and drains.

D. During cold weather, remove ice and snow within forms; do not use de-icing salts; do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure; use compressed air or other means to remove foreign matter.

E. After completion of work of this section, remove from job-site associated debris, tools and equipment.

END OF SECTION 03100

SECTION 03200 - CONCRETE REINFORCEMENT

PART 1. GENERAL

1.01 SCOPE OF WORK: Subcontractor shall furnish all labor, materials, equipment, transportation, supervision and services necessary for the detailing, fabrication, delivery and installation of reinforcing steel and welded wire fabric for cast-in place concrete work as specified herein and as shown on the Subcontract drawings. The work includes, but is not necessarily limited to, the following:

A. Furnishing of reinforcing materials.

B. Detailing of reinforcement.

C. Fabrication of reinforcement.

D. Installation of reinforcement.

E. Providing and installing supports for reinforcing.

F. Providing and installing reinforcing accessories.

G. Reinforcing steel shall include reinforcing bars and welded wire reinforcement. All accessories, tie wire, chairs and bolsters required for the installation of the reinforcing shall also be provided.

1.02 RELATED WORK: The following sections prescribe items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 03100 – Concrete Forms & Accessories.

B. Section 03300 – Cast-in-Place Concrete.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision (including addenda, if any) in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. ACI (American Concrete Institute):

1. ACI 301 - Specifications for Structural Concrete.

2. ACI 315 - Details and Detailing of Concrete Reinforcement.

3. ACI 315R - Manual of Engineering and Placing Drawings for Reinforced Concrete Structures".

4. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

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

1. ASTM A106A - Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

2. A615 Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

C. CRSI (Concrete Reinforcing Steel Institute):

1. "Manual of Standard Practice."

2. "Recommended Practice for Placing Reinforcing Bars."

1.04 SUBMITTALS: The following items shall be submitted to Fermilab for review. Review and release of submittals does not relieve Subcontractor of any of the responsibilities and requirements of this section and the design drawings. Review of the Subcontractor's plans and methods of construction shall not be construed to relieve the Subcontractor in any way of his responsibility for the successful performance of the work.

A. Manufacturer's Certificate of Compliance: Certifies that products supplied meet or exceed specified requirements.

B. Shop Drawings: Shop drawings for fabrication, bending and setting of reinforcing steel. Comply with the requirements of ACI 315 and CRSI showing bar schedules, stirrup spacing, bending schedule and placement of reinforcement and supports.

C. See Exhibit A, Section 12.0, for number and manner of submittals

1.05 QUALITY ASSURANCE AND CONTROL

A. The detailer and fabricator shall have not less than five years experience in the detailing and fabrication of concrete reinforcing steel.

B. The installer shall have a minimum of five (5) years experience in the placement of concrete reinforcing steel.

C. Subcontractor is responsible for quality control and construction inspection in accordance with the requirements of Exhibit A.

D. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and sections shall be required

1.06 PRODUCT DELIVERY, TAGGING AND HANDLING

A. Deliver reinforcement to the job-site bundled and tagged in accordance with CRSI - Manual of Standard Practice. Use metal tags indicating bar size, lengths and other information corresponding to the markings shown on the placement drawings.

B. Reinforcing materials shall be shipped to the job-site new, undamaged and free of rust.

C. Reinforcing materials shall be stored on blocks and cribbing and protected to ensure that no damage or impurities will occur from moisture, dirt, grease or other sources.

PART 2. PRODUCTS

2.01 REINFORCING BARS: ASTM A615, Grade 60, new deformed billet-steel bars, unfinished.

2.02 WELDED WIRE REINFORCEMENT

A. Smooth steel welded wire reinforcement shall conform to the requirements of ASTM A106A and is denoted by the letter "W" followed by a number indicating cross-sectional area in hundredths of a square inch.

B. Deformed steel welded wire reinforcement shall conform to ASTM A106A and is denoted by the letter "D" followed by a number indicating cross-sectional area in hundredths of a square inch.

C. All welded wire reinforcement shall be furnished in flat sheets and shall be tagged with manufacturer's name, size and designation. Rolled material is unacceptable.

2.03 BAR SUPPORTS

A. Wire Bar Supports: Fabricate from cold drawn carbon steel wire or stainless steel wire to the geometry and gauges specified in Table II in the CRSI Manual of Standard Practice.

B. Sand plates (wherever required) of 20-gauge sheet steel welded to support legs.

C. Plastic coating, plastic legs or plastic tips shall be used where legs of supports are in contact with forms or exposed to view concrete surfaces.

D. Pre-cast Concrete Block Bar Supports: Cast from concrete with design strength at least equal to specified strength of structure, provided with two (2)

16 gauge tie wires or hole for No. 4 dowel as appropriate, minimum 4" square, thickness as required for concrete cover.

2.04 WELDED WIRE REINFORCEMENT SUPPORTS

A. Molded Plastic Supports: Sized and shaped to support welded wire reinforcement at the specified depth during concrete placement without breaking or dislodging with bottom pad, where required, to prevent puncture of vapor barrier, if used.

B. Pre-cast Concrete Supports: Cast from concrete with design strength at least equal to specified strength of slab, provided with two (2) 16-gauge tie wires, minimum 4"square, thickness, as required, to position wire reinforcement at specified depth.

2.05 TIE WIRE: ASTM A82, double annealed, minimum 16-gauge.

2.06 SPACERS: Molded plastic, ferrous metal or concrete, sized and shaped to firmly hold reinforcing bars in place and to maintain specified minimum clearance from inside face of forms during concrete placement, without breaking, dislodging or deforming.

2.07 EPOXY ADHESIVE: Manufactured adhesive for anchoring reinforcement into existing concrete:

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to the following:

1. HILTI HY 150.

2. Epcon Granite 5.

3. Simpson Acrylic-TiE.

2.08 MECHANICAL CONNECTIONS OF REINFORCING BARS: Mechanical couplers shall conform to the requirements of ACI 318 and ACI 439.3R for tension compression mechanical connections.

PART 3. EXECUTION

3.01 DETAILING

A. The Subcontractor shall prepare shop fabrication and field placement drawings for all reinforcing steel in accordance with ACI 315, ACI 318 and CRSI - Manual of Standard Practice. Placement drawings shall show the locations and spacing of all reinforcement in the structure. Placement drawings shall be complete so that the reinforcement can be placed without reference to the subcontract drawings.

B. Detailing shall account for the minimum cover as shown on the drawings.

C. All horizontal bars and horizontal portions of bent bars shall be considered “top bars.”

D. Splices shall be staggered and Class B, unless noted otherwise.

E. Full development length shall be provided across joints, unless noted otherwise.

3.02 FABRICATION

A. Fabricate reinforcing in accordance with ACI 315, the CRSI Manual of Standard Practice and from checked and released shop detail drawings.

B. Reinforcing steel shall be accurately bent and cut as detailed:

1. Bars shall be bent cold.

2. Bars shall be shear cut.

3. Heating of bars shall not be permitted.

4. Bars shall not be bent, cut or handled in any other manner that would damage the integrity of the material.

5. Shearing and bending tolerances shall conform to the CRSI Manual of Standard Practice.

3.03 INSPECTION AND PREPARATION

A. Verify that reinforcing is free from twists, dirt, loose rust, scale, oil, grease or other coatings.

B. Verify mark number on tag against placement drawing.

C. Verify reinforcing size and type against drawings.

D. Examine the substrate, formwork and the conditions under which reinforcement is to be placed. Do not place reinforcing until the subgrade preparation has been approved.

3.04 PLACEMENT

A. Place reinforcement according to checked and released drawings and in accordance with ACI 301 and ACI 315.

B. Accurately position, support and secure reinforcement against displacement from formwork construction or concrete placement and consolidation. Support reinforcing on metal chairs, runners, bolsters, spacers and hangers.

C. Locate reinforcing to provide concrete cover and spacing shown on the drawings:

1. Location of bars with respect to spacing and effective depth shall be 1/4” (±) of that shown.

2. Lateral spacing of bars shall be 1” (±) of that shown on the drawings, except where inserts, or other embedded items. may require shifting of bars.

3. Where bars are required to be shifted, or cut due to inserts, embedments or openings and these are not detailed on the drawings, then approval shall be obtained from the Fermilab Construction Coordinator before proceeding. In no case shall the total area of steel provided in a cross section be reduced and typically additional steel will be required.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one (1) full mesh plus 2” and a minimum of 8”. Lace with tie wire.

E. Do not insert dowels into fresh concrete; do not float welded wire reinforcement down into fresh concrete.

F. Support all slab reinforcement at the required depth and secure prior to placing concrete; do not pull welded wire reinforcement up into fresh concrete as it is placed.

G. Welding of and to any reinforcing materials including tack welding of crossing bars is strictly prohibited.

H. Do not cut, bend or straighten bars partially embedded in concrete without specific case-by-case approval of the Fermilab Construction Coordinator. Wires and bars shall be shear cut only. Heat shall not be allowed for cutting or bending of bars.

I. Bars protruding from joints shall be covered and adequately protected from damage. Plastic caps shall be installed on the ends of all protruding bars as required by OSHA.

3.05 CLEANUP: After completion of work of this section, remove from jobsite associated debris, tools and cleanup of this trade.

END OF SECTION 03200

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1. GENERAL

1.01 SCOPE OF WORK: Subcontractor shall furnish all labor, materials, equipment, transportation, supervision and services necessary for the construction and curing of field cast-in-place concrete. The work includes but is not necessarily limited to the following:

A. Building floors, foundations, slabs, walls and pilasters.

B. Transformer and mechanical equipment pads and containment walls.

C. New walkways.

D. Ductbanks thrust blocks and mud mats.

E. Miscellaneous concrete construction in and around proposed CMTF buildings.

1.02 RELATED WORK: The following sections prescribe items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 03100 – Concrete Forms & Accessories.

B. Section 03200 – Concrete Reinforcement.

C. Section 05500 – Miscellaneous Metals.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. ACI (American Concrete Institute):

1. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

2. ACI 212.3 Report on Chemical Admixtures for Concrete.

3. ACI 301 Specifications for Structural Concrete.

4. ACI 302 Guide for Concrete Floor & Slab Construction.

5. ACI 304 Guide for Measuring, Mixing, Transporting and Placing Concrete.

6. ACI 304.2 Placing Concrete by Pumping Methods.

7. ACI 305.1 Specification for Hot Weather Concreting.

8. ACI 306.1 Specification for Cold Weather Concreting.

9. ACI 308.1 Specification for Curing Concrete.

10. ACI 309 Guide for Consolidation of Concrete.

11. ACI 311 Guide for Concrete Inspection.

12. ACI 117 Standard Specification for Tolerances for Concrete Construction and Materials.

13. ACI 318 Building Code Requirements for Structural Concrete.

14. ACI 347 Guide for Concrete Formwork.

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

1. C33 Standard Specification for Concrete Aggregates.

2. C70 Standard Test Method for Surface Moisture in Fine Aggregate.

3. C94 Standard Specification for Ready-Mixed Concrete.

4. C143 Standard Test Method for Slump of Hydraulic-Cement Concrete.

5. C150 Standard Specification for Portland Cement.

6. C171 Specification for Sheet Materials for Curing Concrete.

7. C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

8. C227 Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations.

9. C231 Standard Test Method for Air Content or Freshly Mixed Concrete by the Pressure Method.

10. C260 Standard Specification for Air-Entraining Admixtures for Concrete.

11. C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

12. C494 Standard Specification for Chemical Admixtures for Concrete.

13. C566 Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying.

14. C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzalan for Use in Concrete.

15. D994 Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

16. D1190 Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type.

17. D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics.

18. D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

19. D1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

20. D3575 Standard Test Methods for Flexible Cellular Materials Made From Olefin Polymers.

21. E329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

C. NRMCA - (National Ready Mixed Concrete Association): Checklist for Certification of Ready Mixed Concrete Products.

D. USACE - US Army Corps of Engineers: CRD-C572.

1.04 SUBMITTALS: The following items shall be submitted to Fermilab for review. Fermilab's review will be made to verify that the general scope of work is adequate and that the Subcontractor is qualified to perform the work. Review and release of submittals does not relieve Subcontractor of any of the responsibilities and requirements of this section and the design drawings. Review of the Subcontractor's plans and methods of construction shall not be construed to relieve the Subcontractor in any way of his responsibility for the successful performance of the work.

A. Proposed concrete design mix proportions and supporting documentation as required by ACI 301 and ACI 318. The Subcontractor shall submit the proposed concrete mixes and supporting documentation forming the basis of the mix design not less than 40 days before any concrete is to be delivered. A separate concrete mix shall be submitted for each type of concrete and for each strength of concrete required by the sections. Only concrete mixes reviewed and released by Fermilab shall be used in the work.

B. Copy of current NRMCA Certificate of Conformance for Concrete Production Facilities for supplier's plant(s).

C. Manufacturers' material certifications and qualifying test reports confirming that the materials meet the requirements of the sections shall be submitted for the following:

1. Cement - include brand, source and type.

2. Admixtures.

3. Aggregates - include source, gradation, specific gravities, saturated-surface dry weights and other test results conforming aggregate to ASTM C 33.

4. Curing materials, waterstops, joint fillers.

D. Batch Ticket: A delivery ticket with a serial number shall be supplied with each batch of concrete before unloading at the site. The delivery ticket shall show all information required by Section 16 of ASTM C 94.

E. Manufacturer's data sheets on waterstops, curing compounds and joint fillers.

F. See Exhibit A, Section 12.0, for number and manner of submittals.

1.05 QUALITY ASSURANCE AND CONTROL

A. Ready-mix concrete supplier shall hold current NRMCA Certificate of Conformance for Concrete Production Facilities.

B. There shall be a pre-construction meeting held at the Fermilab site with the Subcontractor, the Subcontractor's concrete supplier, and the Fermilab Construction Coordinator to review the specifications and requirements for the concrete work. This meeting will be scheduled by Fermilab and major items of review will include: specification review; concrete materials and mix design; inspection and testing responsibilities; sampling and testing requirements; sign-off requirements; authority to accept or reject fresh concrete; pouring schedule; pouring procedures; and curing and finishing procedures.

C. All testing and inspection agencies shall meet the requirements of ASTM E329. Tests of concrete will be performed by ACI Concrete Field Testing Technician 1 or equivalent certification.

D. Tolerances:

1. Tolerances for formed concrete surfaces shall be in accordance with Table 4.3.1 of ACI 301, Chapter 3 of ACI 347 and Section 4 of ACI 117

a) Finished flatwork, except for the topping slab at El 721'-0" shall conform the F sub F and the F sub L requirements for Conventional Straightedge as defined in paragraph 4.5.6 of ACI 117.

b) The topping slab at El 721'-0" shall conform to the F sub F and F sub L requirements for Flat as defined in paragraph 4.5.6 of ACI 117.

2. Embedded items shall be within 1/2 in. of their required location.

E. Fermilab Construction Coordinator shall be notified at least forty-eight (48) hours prior to any concrete placement to permit time for review of reinforcing and formwork, and observation of concrete placement.

F. All concrete structures shall be constructed at the locations and in conformance with the lines, grades and dimensions shown on the drawings. The strength of concrete shall be as indicated on the drawings or as specified in this section.

G. All surfaces receiving concrete shall be inspected and accepted by the Fermilab Construction Coordinator prior to placing concrete.

1.06 TESTING

A. The Subcontractor shall be responsible for monitoring, sampling, testing, and inspecting all phases of the work:

1. Field testing shall be performed by Subcontractor's independent testing lab. All testing and inspection agencies shall meet the requirements of ASTM E329. Tests of concrete shall be performed by an ACI Concrete Field Testing Technician 1, or equivalent certification. Tests for mix design shall also be by Subcontractor's independent testing lab.

2. Sampling and testing of delivered concrete shall be conducted by Subcontractor's independent testing service.

3. Concrete shall be sampled, cured, and tested for compressive strength, air content and slump. Compressive test cylinders shall be prepared in sets of three cylinders for each test. Specimens for each test shall be obtained from the same batch of concrete, after about one half of the batch has been deposited.

4. The minimum rate of sampling shall be one set per 50 cu. yds. of concrete of each mixture design placed in the day and at least one (1) set for each structure or foundation.

B. The Subcontractor shall be responsible for all expenses related to the testing and inspection of work not evidencing compliance with the specifications and work done without prior notification of the Fermilab Construction Coordinator. This shall include taking and testing a minimum of three (3) concrete cores in each area of non-compliance.

C. The presence of Fermilab's Construction Coordinator on the jobsite and/or verification testing by Fermilab is not to be presumed to relieve in any degree

the responsibilities of the Subcontractor. Any work that does not meet the requirements of the drawings and specifications shall be repaired or removed and replaced solely at the Subcontractor's expense.

D. Field records, in the form of concrete pour cards, shall be maintained for each concrete placement. As a minimum the following information shall be kept:

1. Concrete Placement: date, time, location, delivery ticket, test samples taken, date of form removal, method of curing and length of curing.

2. Weather conditions: air temperature, relative humidity and wind speed.

E. Subcontractor shall provide assistance and allow Fermilab to perform sampling and verification testing of any phase of the work.

1.07 COLD-WEATHER TEMPERATURE REQUIREMENTS

A. Cold-weather concreting shall be in accordance with ACI 306 and the requirements specified herein.

B. Concrete shall not be mixed or placed when the temperature is below 40°F or when conditions indicate that the temperature will fall below 40°F within twenty-four (24) hours after placing, unless cold weather concreting procedures and precautions are followed.

C. The concrete, formwork and air temperature must be kept at a temperature of not less than 50°F for not less than seventy-two (72) hours after placing.

1.08 HOT-WEATHER TEMPERATURE REQUIREMENTS

A. Hot-weather concreting shall be in accordance with ACI 305 and the requirements specified herein.

B. The maximum placing temperature of the concrete as it is being discharged from the delivery vehicle shall not exceed 90°F. The concrete supplier shall employ effective means, such as pre-cooling the aggregate or pre-cooling the mixing water, to maintain the delivered temperature of concrete at or below 90°F.

1.09 BATCHING, MIXING AND TRANSPORTATION of concrete shall be in accordance with ACI 304 and ASTM C94

A. The batch plant and scales shall meet the standards established by the NRMCA, "Certification of Ready-Mixed Concrete Production Facilities."

B. The batch plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched. Adjustments to the mix shall be made based on a

moisture content determined by ASTM C-70 for fine aggregates and ASTM C-566 for coarse aggregates.

C. The concrete shall be delivered as close to the area of placement as is safely possible.

D. The concrete shall be discharged from the delivery equipment within a maximum of ninety (90) minutes or before the drum has made three hundred (300) revolutions. Timing for the concrete discharge shall start with the introduction of the mixing water.

E. The concrete trucks shall be continuously rotated at the agitating speed while awaiting discharge. If the truck stops agitating for fifteen (15) minutes or longer, the concrete shall be re-blended by rotating the drum at the mixing speed for a minimum of ten (10) revolutions prior to discharging.

PART 2. PRODUCTS

2.01 CEMENT

A. Portland cement shall be Type I, conforming to ASTM C-150.

B. Only one (1) brand and source of cement shall be used for all work on the Subcontract, unless otherwise specifically authorized. The brand and source shall provide a uniform color for all exposed concrete.

2.02 AGGREGATES

A. Aggregates shall conform to ASTM C-33.

B. Fine aggregate shall be uniformly graded, clean, sharp, washed natural or crushed sand, free from organic impurities.

C. Coarse aggregate shall be natural washed gravel or washed crushed rock having hard, strong, durable pieces, free from adherent coatings.

D. Maximum sizes of coarse aggregates shall be 3/4 in. in accordance with the requirements of ASTM C-33 gradation size no. 67. In slabs 2'-0" or greater in thickness the maximum sizes of course aggregate shall be 1 ½" in accordance with the requirements of ASTM C-22 gradation size no. 467.

2.03 WATER: Water used in the concrete mix shall be potable, clean and free from oils, acids, salts, chlorides, alkali, sugar, vegetable or other injurious substances.

2.04 ADMIXTURES

A. Admixtures shall contain no chlorides.

B. The concrete shall contain an air-entraining admixture and a water-reducing admixture. No other admixtures shall be used unless reviewed and approved by Fermilab. Admixtures shall be purchased and batched in liquid solution. The use of calcium chloride or an admixture containing calcium chloride is prohibited.

C. Admixtures shall be of the same manufacturer to assure compatibility. Acceptable manufacturers are:

1. Sika Corp.

2. Master Builders.

3. Euclid Chemical Co.

D. The air-entraining admixture shall comply with the requirements of ASTM C-260 and ACI 212.1R.

E. The water-reducing admixture shall be Type A or Type D complying with the requirements of ASTM C-494 and ACI 212.1R. Type A shall generally be used throughout unless increased setting time is required, in which case Type D shall be used.

2.05 REINFORCING STEEL shall conform to Section 03200, Concrete Reinforcement.

2.06 CURING MEMBRANE shall be non-staining paper conforming to ASTM C-171 or 6 mil thick polyethylene film.

2.07 CURING AND SEALING COMPOUNDS shall be a clear acrylic-based compound. Acceptable products are:

A.	L & M Construction Products	Dress and Seal.
B.	Sonneborn	Kure-N-Seal.
C.	W. R. Meadows	CS-309/30-Clear.

2.08 WATERSTOPS

A. PVC Waterstops shall be flat serrated ribbed type extruded PVC conforming to the U.S. Army Corp of Engineers specification CRD-C572.

B. Self-expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, ¾” to 1” wide 3/8” to ½” thick, sodium bentonite or other hydrophilic material for adhesive bonding concrete:

1. Available Products: Subject to compliance with requirements products that may be incorporated into the Work include, but are not limited to the following:

a) Volclay Waterstop-RX; Colloid Environmental Technologies Co.

b) Hyrdotite: Greenstreak.

c) Stop; Carlisle Coatings and Waterproofing.

2.09 EMBEDS AND INSERTS

A. Embedded plates, sleeves, inserts and other items shall be provided as shown on the drawings.

B. Refer to Section 05500: MISCELLANEOUS METALS for miscellaneous steel embedments.

2.10 PREMOLDED JOINT FILLER for expansion or isolation joints shall be preformed sheets or strips of durable, elastic rubber or clean granulated cork particles securely bonded together by an insoluble synthetic resin meeting the requirements of ASTM D1752 Types I or II.

2.11 CAULKING AND PATCHING MATERIAL for grout holes, nipples, joints, and cracks shall be epoxy grout or rapid setting structural mortar suitable for overhead applications, or other suitable materials subject to approval by Fermilab.

2.12 CONCRETE MIX

A. Separate mix designs are required for each type and change in mix materials. Separate mix designs are also required for concrete that is to be placed by pumping methods.

B. The guidelines of ACI-301 and ACI-211.1 shall be adhered to in design and proportioning of the concrete mix. Proportioning shall be on the basis of field experience and/or trial mixtures.

C. The cement content and water cement ratio shall be within the following limits for each strength class, with these requirements adhered to even though test cylinder results may show higher strengths.

Strength Class 28 Days	**Minimum Cement Content**	**Maximum Water/Cement Ratio**	**Application**
2,000 psi	376 lbs/C.Y.	0.74	Mud mats, Thrust blocks & Ductbank
3,500 psi	470 lbs./C.Y.	0.44	Concrete Paving
4,000 psi	470 lbs/C.Y.	0.44	Structural Concrete

D. The water-cement ratio shall be the weight of water divided by the weight of cement and flyash entering the mixture. The total quantity of water shall be adjusted for the free moisture contributed by the fine and coarse aggregates. No water shall be added to the concrete after it has left the mixer.

E. The concrete mix shall be designed for a maximum slump of 3” ± 1” at the point of discharge. Slump for pumped concrete may be higher but in no case greater than 5” ± 1”. In no case shall the water/cement ratio be increased. Mixes of the stiffest consistency that can be efficiently placed shall be used.

F. All concrete shall have 4 percent – 6 percent entrained air.

G. All structural concrete shall contain a water-reducing agent.

H. Fly ash may be incorporated in the concrete mix design under the following conditions:

1. Class C fly ash may be used as a replacement for cement at a ratio of one and one-half (1-1/2) parts fly ash to one (1) part cement replaced up to a maximum of 15 percent replacement.

2. Class F fly ash may be used as a replacement for fine aggregate only. Total cement shall remain the same as the design without fly ash.

3. The use of fly ash is subject to Fermilab's approval.

I. No changes in the concrete mix may be made by the Subcontractor during the progress of the work without prior review and release by Fermilab. To obtain review and release of a mix change, the Subcontractor shall provide conclusive evidence that the proposed concrete mix will meet the specified requirements.

J. If during the progress of the work it is found impossible to achieve concrete of the required workability and strength with the materials being furnished, Fermilab may order, without additional cost, such changes in proportions or materials, or both, as may be deemed necessary to achieve concrete of the specified quality.

2.13 NON METALLIC SHRINKAGE RESISTANT GROUT Premixed, nonmetallic, non corrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents complying with ASTM C1107, of consistency suitable for application and thirty (30) minute working time.

2.14 SHEET VAPOR RETARDER: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

2.15 ISOLATION JOINT FILLER

A. Sealant system shall be comprised of three components: 1) Cellular polyurethane foam impregnated with hydrophobic 100% acrylic, water-based emulsion, factory coated with highway-grade, fuel resistant silicone. Impregnation agent to have proven non-migratory characteristics. 2) Field-applied epoxy adhesive primer. 3) Field-injected silicone sealant bands. Silicone coating to be highway-grade, low-modulus, jet-fuel resistant silicone applied to the impregnated foam sealant at a width greater than maximum allowable joint extension and which when cured and compressed will form a bellows.

B. Depth of seal as recommended by manufacturer. The seal to be installed into manufacturer's standard field-applied epoxy adhesive. The seal is to be installed slightly recessed from the surface such that when the field-applied injection band of silicone is installed between the substrates and the foam-and-silicone-bellows, the system will be essentially flush with the substrate surface.

C. Material shall be capable, as a dual seal, of movements of +30 percent, -25 percent (55 percent total) of nominal material size.

D. Seal shall be free in composition of any waxes or asphalts, wax compounds or asphalt compounds. Seal shall be certified in writing to be: a) capable of withstanding 150°F (65°C) for 3 hours while compressed down to the minimum of movement capability dimension of the basis of design product (-25 percent of nominal material size) without evidence of any bleeding of impregnation medium from the material; and b) that the same material after the heat stability test will self-expand to the maximum of movement capability dimension of the basis-of-design product (+30 percent of nominal material size) within 24 hours at room temperature 68°F (20°C).

PART 3. EXECUTION

3.01 PREPARATION BEFORE PLACING

A. Placement surfaces shall be accepted by the Fermilab Construction Coordinator before placing concrete.

B. Prior to placing concrete, the forms and reinforcement shall be thoroughly inspected. All wood chips, dirt, and other debris, etc., shall be removed; all temporary bracing, ties and cleats removed; all openings for utilities properly boxed; all forms properly secured in their correct position and made tight. All reinforcement, anchor bolts and other embedded items shall be secured in their proper locations. All old and dry concrete and dirt shall be cleaned off and all standing water and other foreign matter removed.

3.02 VAPOR RETARDERS

A. Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6" and seal with manufacturer's recommended tape.

B. Granular Course: Compact granular capillary barrier to design subgrade elevation plus 0" or minus ¾" prior to applying vapor retarder.

3.03 CONSTRUCTION JOINTS

A. Construction joints shall be placed at the locations indicated on the drawings. Joints that have to be made at locations other than those shown on the drawings shall be approved by Fermilab and located to least impair the strength of the structure.

B. Reinforcement shall be continued across joints with full development length provided, unless the drawings show otherwise. Construction joints shall be keyed as shown. The joint surfaces shall be cleaned of scale and laitance.

C. When specified as a "bonded construction joint," the joint shall be thoroughly wetted and washed with a coat of neat cement grout prior to the new pour.

3.04 ISOLATION AND EXPANSION JOINTS

A. Isolation and expansion joints shall be located and constructed as shown on the drawings. When reinforcing dowels are shown extending through a joint, they shall be smooth and the protruding end greased to prevent bonding.

B. Joints shall be installed with the top edge of the joint filler ½" below the top of the concrete. The edges of the joint shall be tooled to a 1/8" radius and the

remaining joint space cleaned, dried and filled to the top edge of the surface with approved joint sealant.

3.05 COMPRESSIBLE FILLER

A. Install compressible joint filler in accordance with manufacturer's instructions.

B. Attach expansion joint filler securely to the existing concrete slab, coping or form with tape or mechanical fasteners prior to pouring the concrete slab.

C. Ensure that the expansion joint filler is level with the desired slab surfaces prior to finishing.

D. Remove the pre-scored strip and apply joint sealant.

E. Fill joint with sealant.

3.06 EMBEDDED ITEMS

A. All anchorage devices, inserts, sleeves and other embedded items shall be set and built into the work in accordance with the drawings.

B. Embedded items shall be set accurately in location, alignment, elevation and plumbness. Locate and measure from established surveyed reference benchmarks.

C. Embedded items shall be anchored into place in a manner to prevent movement during concrete placement and consolidation. Components forming a part of a complete assembly shall be aligned before anchoring into place. Provide temporary bracing, anchorage and templates as required to maintain the setting and alignment.

D. Sleeves and other embedded items shall not be set on main reinforcing steel and shall have a minimum 1” gap to the steel. Threads and open areas of sleeves shall be protected from damage and intrusion of concrete.

3.07 STEEL PAN STAIRS

A. Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.08 HANDLING AND DEPOSITING

A. Placing of concrete shall be in accordance with ACI 301 and ACI 304 and shall be carried out at such a rate that the concrete previously placed is still plastic and integrated with the freshly placed concrete. Concreting, once

started, shall be carried on as a continuous operation until the section is completed. No cold joints shall be allowed.

B. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods that will prevent segregation or loss of ingredients. Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling.

C. Pumped concrete shall follow the recommendations of ACI 304.2. Aluminum alloy pipeline shall not be used. After a pour has been completed, any concrete remaining in the pipeline shall be wasted.

D. Concrete shall not be dropped freely onto reinforcing, thereby causing segregation, nor shall it be dropped freely more than 5’-0”. Concrete shall be deposited in a manner to maintain an approximately level horizontal surface.

E. Concrete that has partially hardened shall not be deposited in the work. Concrete shall not be re-tempered nor used after having stood for 15 minutes after leaving the truck or mixer.

F. Concrete that is delivered with a slump below that suitable for proper placing, specified in this Section, may have additional water authorized only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Any addition of water above that permitted by the limitation on water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio. Any additional water shall only be as authorized in writing by the Fermilab Construction Coordinator. In no case shall water be added after the concrete has left the mixer.

3.09 VIBRATING AND COMPACTING

A. All concrete shall be thoroughly consolidated and compacted by vibration, spading, rodding or forking during the operation of placing and depositing in accordance with ACI 309. The concrete shall be thoroughly worked around reinforcement, embedded items and into the corners of the forms to eliminate all air and stone pockets. Internal vibrators shall be the largest size and the most powerful that can be properly used as described by ACI 309. They shall be used by experienced workers under experienced supervision and shall be kept from bearing against reinforcement and forms. Vibrators shall not be used in a manner that forces mortar between individual form members. Vibrators shall not be used to transport concrete within the forms. Form vibrators shall not be used.

B. Vibrators shall be inserted and withdrawn in points approximately 18” apart. At each point the duration shall be sufficient to consolidate the concrete but not cause segregation. The time of insertion shall generally be five (5) to fifteen (15) seconds. Vibration shall be close to the forms, but shall not be continued at one spot to the extent that large areas of grout are formed or the

heavier aggregates are caused to settle. Care shall be taken not to disturb the concrete after it has taken its initial set.

3.10 PATCHING

A. After removing all forms and attachments, all tie holes, pour and form joints, voids, pockets, honeycombs and other aesthetic defects shall be patched in accordance with ACI 301, Chapter 9.

B. Defects impairing the structural integrity or strength of the structure shall require special repairs or removal as determined and directed by the Fermilab Construction Coordinator.

3.11 PROTECTION AND CURING

A. Freshly placed concrete shall be protected from injurious action of the elements and defacement of any kind during the construction operations in accordance with ACI 308.

B. Exposed concrete edges shall be carefully protected from traffic or use that may cause damage.

C. Curing:

1. The concrete shall be kept in a thoroughly moist condition from the time of placement until it has cured for at least seven (7) days.

2. All forms shall be kept sufficiently wet to prevent drying of the concrete. Continue curing concrete for remainder of curing period upon removal of forms.

3. The use of liquid-membrane curing compounds must be approved by the Fermilab Construction Coordinator for each specific location. When used, they shall be applied in two (2) layers, sprayed in perpendicular directions, in two separate applications. The first application shall be at eh time of the concrete placement in accordance with the manufacturer's instructions and the second application just prior to Beneficial Occupancy.

D. Surfaces of floor slabs shall have a smooth trowel finish without membrane curing compound.

3.12 SETTING BASE PLATES AND BEARING PLATES

A. After being properly positioned, bearing plates for beams and similar structural members and machinery, column base plates, and equipment base plates shall be set to the proper line and elevation with non-metallic shrinkage resistant grout. The thickness of the grout shall be as shown on the drawings.

Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed.

B. Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. Batches should be of size to allow continuous placement of freshly mixed grout. Grout not used within thirty (30) minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown on the initial set shall be avoided. Grout shall not be re-tempered or subjected to vibration from any source. Where clearances are unusually small, grout shall be placed under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85°F until after setting.

3.13 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.

2. Do not apply to concrete that is less than seven days old.

3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

END OF SECTION 03300

SECTION 04200 – Unit Masonry

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Concrete masonry units (CMUs).
2. Mortar and grout
3. Reinforcing steel
4. Masonry Joint reinforcement.
5. Ties and anchors.
6. Miscellaneous masonry accessories

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, “Details and Detailing of Concrete Reinforcement.” Show elevations of reinforced walls.

1.03 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product indicated. For masonry units include material test reports substantiating compliance with requirements.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.04 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for

these characteristics, through one source from a single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

D. Testing:

1. Masonry testing shall be performed by independent testing laboratory at Subcontractor's expense. Material and labor required to construct prisms and other test samples shall be provided by Subcontractor.

2. Subcontractor's testing agency shall issue monthly reports directly to the Owner for review.

3. Masonry shall be tested in accordance with section 1704.5.2 and Table 1704.5.1 of the 2009 International Building Code, and as set forth in ACI-530/ASCE6:

a) Level 1 Required Verification and Inspection of Masonry Construction:

TABLE 1704.5.1
LEVEL 1 REQUIRED VERIFICATION AND INSPECTION OF MASONRY CONSTRUCTION

VERIFICATION AND INSPECTION	FREQUENCY OF INSPECTION		REFERENCE FOR CRITERIA		
	CONTINUOUS	PERIODIC	IBC SECTION	TMS 402/ACI 530/ASCE 5[a]	TMS 602/ACI 530.1/ASCE 6[a]
1. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.	—	X	—	—	Art. 1.5
2. Verification of f'_m and f'_{AAC} prior to construction except where specifically exempted by this code.		X	—	—	Art. 1.4B
3. Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	X	—	—	—	Art. 1.5B.1.b.3
4. As masonry construction begins, the following shall be verified to ensure compliance:					
a. Proportions of site-prepared mortar.	—	X	—	—	Art. 2.6A
b. Construction of mortar joints.	—	X	—	—	Art. 3.3B
c. Location of reinforcement, connectors, prestressing tendons and anchorages.	—	X	—	—	Art. 3.4, 3.6A
d. Prestressing technique.	—	X	—	—	Art. 3.6B
e. Grade and size of prestressing tendons and anchorages.	—	X	—	—	Art. 2.4B, 2.4H
5. During construction the inspection program shall verify:					
a. Size and location of structural elements.	—	X	—	—	Art. 3.3F
b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.	—	X	—	Sec. 1.2.2(e), 1.16.1	—
c. Specified size, grade and type of reinforcement, anchor bolts, prestressing tendons and anchorages.	—	X	—	Sec. 1.15	Art. 2.4, 3.4
d. Welding of reinforcing bars.	X	—	—	Sec. 2.1.9.7.2, 3.3.3.4(b)	—
e. Preparation, construction and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F).	—	X	Sec. 2104.3, 2104.4	—	Art. 1.8C, 1.8D
f. Application and measurement of prestressing force.	X	—	—	—	Art. 3.6B

TABLE 1704.5.1-continued
LEVEL 1 REQUIRED VERIFICATION AND INSPECTION OF MASONRY CONSTRUCTION

VERIFICATION AND INSPECTION	FREQUENCY OF INSPECTION		REFERENCE FOR CRITERIA		
	CONTINUOUS	PERIODIC	IBC SECTION	TMS 402/ACI 530/ASCE 5[a]	TMS 602/ACI 530.1/ASCE 6[a]
6. Prior to grouting, the following shall be verified to ensure compliance:					
a. Grout space is clean.	—	X	—	—	Art. 3.2D
b. Placement of reinforcement and connectors, and prestressing tendons and anchorages.	—	X	—	Sec. 1.13	Art. 3.4
c. Proportions of site-prepared grout and prestressing grout for bonded tendons.	—	X	—	—	Art. 2.6B
d. Construction of mortar joints.	—	X	—	—	Art. 3.3B
7. Grout placement shall be verified to ensure compliance:	X	—	—	—	Art. 3.5
a. Grouting of prestressing bonded tendons.	X	—	—	—	Art. 3.6C
8. Preparation of any required grout specimens, mortar specimens and/or prisms shal be observed.	—	X	Sec. 2105.2.2, 2105.3	—	Art. 1.4

1.05 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover top of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2. PRODUCTS

2.01 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing

according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.02 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Provide square-edged units for outside corners and at door jambs, unless otherwise indicated.

C. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength for exposed units and where indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a) ACM Chemistries, Inc.; RainBloc.

b) BASF Aktiengesellschaft; Rheopel Plus.

c) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

D. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi unless noted otherwise on documents.

2. Density Classification: Normal weight unless otherwise indicated.

2.03 MASONRY LINTELS

A. General: Provide masonry lintels, complying with the following:

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout.

2.04 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color.

B. Hydrated Lime: ASTM C 207, Type S or N for interior work.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91.

E. Aggregate for Mortar: ASTM C 144.

1. For joints less than ¼" (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

F. Aggregate for Grout: ASTM C 404.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a) Euclid Chemical Company (The); Accelguard 80.

b) Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.

c) Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs, containing integral water repellent by same manufacturer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a) ACM Chemistries, Inc.; RainBloc for Mortar.

b) BASF Aktiengesellschaft; Rheopel Mortar Admixture.

c) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

2. Water: Potable.

2.05 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.

2. Exterior Walls: Hot-dip galvanized, carbon steel.

3. Wire Size for Side Rods: 0.148-inch diameter.

4. Wire Size for Cross Rods: 0.148-inch diameter.

5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.

6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.06 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.

2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel wire.

2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch diameter, hot-dip galvanized steel wire.

C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete; formed from 0.060”-thick, steel sheet, galvanized after fabrication.

2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187”-diameter, hot-dip galvanized steel wire.

D. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.07 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142” steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.

2.08 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use Portland cement-lime mortar unless otherwise indicated.

3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide type S mortar unless another type is indicated.

D. Grout for Unit Masonry: Furnish core fill grout ingredients in form of a preblended mix. Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.

2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength of not less than 2000 psi.

3. Provide grout with a slump of 8 to 11” as measured according to ASTM C 143/C 143M.

PART 3. EXECUTION

3.01 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus ½” or minus ¼”.

2. For location of elements in plan do not vary from that indicated by more than plus or minus ½”.

3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or ½” total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than ¼” in 10’, or ½” maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8” in 10’, ¼” in 20’, or ½” maximum.

3. For vertical lines and surfaces do not vary from plumb by more than ¼” inch in 10’, 3/8” in 20’, or ½” maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8” in 10’, ¼” in 20’, or ½” maximum.

5. For lines and surfaces do not vary from straight by more than ¼” in 10’, 3/8” in 20’, or ½” maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8” with a maximum thickness limited to ½”.

2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8” or minus.

3. For exposed head joints, do not vary from thickness indicated by more than plus or minus.

3.02 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

C. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4” horizontal face dimensions at corners or jambs.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

G. Fill cores in hollow CMUs with grout 24” under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

H. Concrete/grout-fill 100 percent first course laid directly on concrete slabs.

3.03 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.

2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.

4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.04 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8” on exterior side of walls, ½” elsewhere. Lap reinforcement a minimum of 6”.

1. Space reinforcement not more than 16” o.c. vertically.

2. Provide reinforcement not more than 8” above and below wall openings and extending 12” beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.05 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than ½” wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure where indicated.

3. Space anchors as indicated, but not more than 24” o.c. vertically and 36” o.c. horizontally.

3.06 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than 60”.

3.07 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor’s expense.

B. Inspections: Level 1 special inspections according to the “International Building Code.”

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

D. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

E. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for compressive strength.

F. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.08 REPAIRING, POINTING AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.09 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18” of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner’s property.

END OF SECTION 04200

SECTION 05120 - STRUCTURAL STEEL

PART 1. GENERAL

1.01 SCOPE OF WORK: Subcontractor shall furnish all labor, materials, equipment, testing and supervision necessary and required to detail, furnish, fabricate and erect all structural steel work.

1.02 RELATED WORK: The following sections prescribe items of related work. Coordinate work prescribed by this section with work prescribed by the following sections:

A. Section 03300 – Cast-in-Place Concrete.

B. Section 05320 – Metal Deck.

C. Section 05500 – Miscellaneous Metals.

D. Section 05510 – Metal Stairs.

E. Section 09900 – Painting.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum (addenda) in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications.

A. AISC (American Institute of Steel Construction).

1. Shop Painting and Painting Practice.

2. Specification for Structural Steel Buildings (ANSI/AISC 360-05).

3. Code of Standard Practice for Structural Steel Buildings and Bridges (AISC 303).

4. Specification for Structural Joints Using ASTM A 325 and A 490 Bolts (AISC 348).

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

1. A-36 Standard Specification for Carbon Structural Steel.

2. A-53 Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless Pipe.

3. A-307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psu.

4. A-325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum.

5. A-500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

6. A-563 Standard Specification for Carbon and Alloy Steel Nuts.

7. F-436 Standard Specification for Hardened Steel Washers.

8. A-992 Specification for Steel for Structural Shapes.

9. F-959 Standard Specification for Compressible-Washer-Type Direct Tension Indicators for use with Structural Fasteners.

10. F-1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.

C. AWS (American Welding Society)

1. AWS D1.1 Structural Welding Code.

D. Steel Structures Painting Council (SSPC)

1. Painting Manual.

1.04 SUBMITTALS: The following items shall be submitted to Fermilab for review and release. Fermilab's review will be made to verify that the scope of work is in general conformance with the drawings and specifications and that the Subcontractor is qualified to perform the work. Review and release of submittals does not relieve Subcontractor of any of the responsibilities and requirements of this Section and the design drawings. Review of the Subcontractor's plans and methods of construction shall not be construed to relieve the Subcontractor in any way of his responsibility for the successful performance of the work.

A. Shop drawings: Drawings are required for Fermilab's review. The Subcontractor shall submit complete shop drawings, including detail, fabrication and erection diagrams, before fabrication is started:

1. Shop drawings shall give complete information necessary for the fabrication and erection of the steel and shall clearly distinguish between shop and field bolts and welds.

2. Weight of each member on detail drawings shall be identified in the bill of material tables along with a summary of total weight per classification on each detailed sheet. Bolting material shall also be identified on each detail drawing.

B. Non-Destructive Examination (NDE) testing procedures, detailing and fabrication schedules.

C. Manufacturer's Certifications of Compliance and Producers Reports on structural steel materials and structural bolts and hardware.

D. Qualified welding procedures and welder's certifications.

E. See Exhibit A, Section 12.0 – Shop Drawings, Material Submittals and Samples, for number and manner of submittals.

F. Paint:

1. Product Data: Submit manufacturer's specifications, including paint label analysis and application instructions for each material specified.

2. Samples: Submit samples for Fermilab review of color and texture only. Compliance with other requirements is exclusive responsibility of Subcontractor. Provide listing of material and application for each coat of each finish sample. Accepted samples shall serve as standard for similar work throughout project. On 12" x 12" hardboard, provide two (2) samples of each color and material with texture to simulate actual conditions.

1.05 QUALITY ASSURANCE AND CONTROL

A. Acceptable Steel Fabricator: Firm with no fewer than five (5) years continuous experience in steel fabrication or with an AISC Certified Category I facility for the past three (3) years.

B. Acceptable Erector: A firm with no fewer than five (5) years continuous experience in steel erection of projects of comparable size and scope.

C. Acceptable Detailer: A firm with no fewer than five (5) years continuous experience in steel detailing of projects of comparable size and scope.

D. Inspection: Fermilab reserves the right to inspect and perform quality control work on the premises of the Subcontractor prior to and during fabrication and before shipment. The Subcontractor shall furnish to Fermilab the shop schedule so that Fermilab's representative can examine the work in progress as well as that which is completed accordingly:

1. All field and shop NDE shall be performed by the Subcontractor with reports and logs available for review by Fermilab.

2. Fermilab may also perform verification testing with their independent testing agency.

1. The Subcontractor shall provide Fermilab assistance and access to scaffolding, work platforms, hoisting facilities for inspection and testing of the work in the shop and in the field during erection.

2. Fermilab reserves the right to reject any material, at any time before final acceptance that does not conform to all of the requirements of the drawings and sections.

E. Subcontractor is responsible for quality control and construction inspection in accordance with the requirements of Exhibit A.

F. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and sections shall be required.

1.06 NON-DESTRUCTIVE EXAMINATION (NDE)

A. All field and shop NDE shall be performed by the Subcontractor with reports and logs available for review by Fermilab.

B. Visual Inspection:

1. The acceptance criteria for visual examination of welding for all categories of joints shall be in accordance with AWS D1.1.

2. Subcontractor shall visually inspect all completed welds against the requirements of AWS D1.1. Undercutting beyond the limits of AWS D1.1, surface porosity and crack-like discontinuities shall be removed to sound metal and repaired.

C. Nondestructive Examination (NDE) of Welds: NDE shall be performed on welded structural joints as noted on the drawings and as listed herein.

1. NDE shall be in accordance with AWS D1.1, Part 6.

2. All full penetration welds shall be magnetic particle tested.

3. Five percent of the total number of fillet or partial penetration welds shall be Magnetic Particle tested 100 percent of the entire length of the welds selected. If the weld is rejected then two (2) additional welds shall be tested. This procedure of testing two (2) additional welds for every single weld rejected shall continue until all welds examined are accepted. The replaced welds shall also be re-examined. The welds selected for testing shall represent a sample of each welder’s work.

D. Examination of Bolting: Bolting inspection shall be visual and in accordance with the AISC Specification for Structural Joints.

1.07 PRODUCT DELIVERY AND HANDLING

A. Deliver materials to job-site and store in a safe area away from traffic. All members shall be carefully handled during shipment and off-loading to prevent abrasion of shop finish or damage to members. Fabric or nylon slings and ties shall be used after the steel has been coated. Protect all materials with wood dunnage as required.

B. All structural materials shall be stored close together and shored upon platforms, skids or other supports placed on properly drained ground to prevent undue deformation, both at the fabricator's shop and in the field.

C. All materials shall be kept free from dirt or other foreign matter and protected from rust and corrosion.

D. Keep material clearly identified with identification marks legible. Keep damaged material identified as damaged and store separately to prevent its unauthorized use.

E. Packaged materials shall be delivered and stored in their original unbroken factory containers bearing manufacturer's name, brand name, shelf life, identification code and description of contents.

PART 2. PRODUCTS

2.01 MATERIALS: All materials shall be new and shall conform to the following ASTM material requirements. All structural steel material, bolting materials and welding materials shall have been produced in the United States and be supplied with manufacturer’s Certificates of Compliance.

A. Unless noted otherwise, all structural steel plates and bars shall conform to ASTM A 36, as indicated on the drawings.

B. Wide Flange shapes shall conform to ASTM A992.

C. Structural tubing (HSS sections) shall conform to ASTM A 500, Grade B.

D. Structural steel pipe shall conform to ASTM A 53.

E. High-strength structural bolts shall conform to ASTM A 325, Type 1 or 2:

1. Fermilab may inspect for suspect/counterfeit bolts and will reject any found as unacceptable for use on this Subcontract, regardless of the application or stress level. It is the responsibility of the Subcontractor to verify that suspect/counterfeit bolts are not used on this Subcontract.

2. All bolting materials shall be furnished with Producer’s Reports and Manufacturer’s Certification.

F. Nuts for all high-strength bolts shall conform to ASTM A 563 C.

G. Flat circular washers and square beveled washers for structural bolts shall conform to ASTM F 436.

H. Load Indicator Washers shall be used as the approved direct tension indicator and shall comply with ASTM F959.

I. All high-strength bolts, nuts and hardened washers shall be distinctly marked as mandated by ASTM and AISC.

J. Headed Anchor Rods shall conform to ASTM F 1554, Grade 36 and be straight.

K. Threaded Rods shall conform to ASTM A36.

L. Weld metal shall have a minimum tensile strength of 70,000 psi.

M. Paint: All interior structural steel shall be painted in accordance with Section 9900, and Section 3.02 of this spec.

N. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A 123. Hot-dip galvanized hardware indicated for galvanizing to comply with ASTM A 153.

O. Grout shall conform to ASTM C 1107 and be shrinkage-resistance nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

P. Adhesive anchors shall be Hillti HAS with Hit-Hy150 adhesive or approved equal. Installation shall be in accordance with manufacturer's recommendations.

Q. Headed studs: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel, AWS D1.1/D1.1M, Type B.

PART 3. EXECUTION

3.01 FABRICATION

A. Connections:

1. The fabricator shall furnish two sets of released erection and detail diagrams and piece mark index sheets in a waterproof package with each shipment of steel.

2. All shop framing connections shall have connection angles welded or bolted with high-strength bolts to the beams. Connection angles shall

be a minimum 5/16" thick. Bolted connections shall have a minimum of two (2) fasteners per connection or equivalent welds.

3. Bolt sizes shall conform to the ASTM standard A 325 – ¾" diameter, minimum.

4. Unless welding is specified on the drawings, all field connections shall be bolted. Holes shall be punched or drilled and shall not be enlarged by burning.

5. Square beveled washers shall be supplied for all connections to channel flanges or other sloping surfaces. Oversize plate washers shall be furnished for all slotted connections.

6. All high strength steel bolts, nuts and washer requirements shall be identified on the shop detail drawings.

7. Gusset and stiffener plates shall not be less than 3/8" thick.

B. Double-angle members shall have fillers spaced in accordance with the requirements of the AISC Specification.

C. Each shipping piece shall carry fabricator's erection mark. Erection marks shall be applied to structural steel member by painting, tagging or other suitable means that will enable the Subcontractor to identify pieces for shipment and erection. Coatings used for erection marks shall not be water-soluble.

D. Welding shall be in accordance with AWS D1.1. Electroslag welding shall not be permitted. Preheat and interpass temperatures shall be applied as required in AWS D1.1 for the quality of base metal being welded. Welds made by procedures that are not pre-qualified or have not been properly qualified shall be rejected.

3.02 PAINTING

A. Except for steel to be galvanized, all structural steel shall be shop primed. Exposed structural steel shall receive two field-applied finish coats. See specification Section 09900.

B. Shop painting and surface preparation shall be in accordance with the provisions of the SSPC and the AISC "A Guide to Shop Painting of Structural Steel" and as specified herein.

C. Prior to delivery and erection, abrasive blast in accordance with SSPC-SP6. Blast profile shall be compatible with primer paint.

3.03 ERECTION

A. All structural steel shall be erected in accordance with the design drawings, the erection and shop detail drawings, the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings and the AISC Code of Standard Practice for Steel Buildings and Bridges.

B. Steel shall be erected plumb, square and true to line and level in the positions as indicated.

C. Bearing plates or setting plates shall be leveled on steel wedges or shims and fully grouted.

D. All common erection bolts shall be replaced with high-strength bolts.

E. The Subcontractor alone shall be responsible for the correct fitting of all structural members and for the elevation and alignment of the finished structure. Any adjustments necessary in the steel framing because of discrepancies in elevations and alignment shall be the responsibility of the Subcontractor.

3.04 FIELD BOLTING

A. Field connections shall be made with high-strength bolts of the size and type indicated on the shop drawings, unless shown or specified otherwise and in accordance with the requirements of the AISC Specification for Structural Joints.

B. All bolts, nuts and washers shall be stored in containers located in relatively noncorrosive, dry areas.

C. Bolts shall be placed into the holes without damaging the threads. Bolt heads shall be held with a spud wrench during driving. Bolt heads and nuts shall rest squarely against the steel.

D. Where bolts are used on beveled surfaces, such as the inside flange of channels, having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be used.

E. Hardened washers shall be installed over oversize holes and short slotted holes in an outer ply and always under the element turned during tightening. A plate washer of minimum 5/16” thick shall be used over all long slotted holes in an outer ply in addition to any hardened washer requirements. Load indicator washers shall not be substituted for the above washer requirements. All high strength bolted connections shall be pre-tensioned to a bolt tension of 28,000 lbs. for ¾” A-325.

F. Bolt tightening shall be performed by use of impact wrenches with a regulated compressed air supply. Bolting crews shall make at least two (2) passes on each connection, tightening from the most rigid part of the connection to its free edges on each pass. The first pass shall draw all the plies of steel together to a “snug tight” condition. Final tightening of pre-tensioned bolts should follow and be accomplished in ten (10) to fifteen (15) seconds maximum.

G. Bolts in connections not identified as slip-critical nor subject to tension loads nor required to be fully tensioned bearing- type connections need only be tightened to the snug tight condition. All such bolts shall be clearly identified on the erection drawings otherwise bolts shall be fully pre-tensioned.

H. All connections other than those identified in paragraph G. above shall be pre-tensioned to a bolt tension of 28,000 lbs. for 3/4” A-325. Install in properly aligned holes in accordance with paragraph 8.(d)(4), “Direct Tension Indicator Tightening” of the AISC Specification for Structural Joints and in accordance with ASTM F-959, using direct tension indicators (DTI) as manufactured by Cooper and Turner or approved equal. Install DTIs in accordance with the manufacturer's requirements and the following:

1. The protrusions of the DTI shall always bear against a hardened unturned surface, normally either the underside of the bolt head or hardened washer, but never directly against the turned element. A nut is not a hardened element. It is important that the proper size washer be used for each bolt:

   a. DTI Under the Bolt Head - Turn the Nut to Tighten

      The preferred installation is to install the DTI under the bolt head with the DTI protrusions bearing against the hardened portion of the bolt head. Turn the nut to tighten while holding the bolt head with a spud wrench.

   b. DTI Under the Nut - Turn the Nut to Tighten

      When it is too difficult to see the bolt head for inspection then the DTI may be placed under the nut with the protrusions facing the nut and a hardened washer used between the nut and the DTI. Turn the nut to tighten while holding the bolt head with a spud wrench. Additional hardened or plate washer requirements are to be added under the DTI.

   c. DTI Under the Bolt Head - Turn the Bolt Head to Tighten

      Install the DTI under the bolt head with the protrusions facing the bolt head and bearing against a hardened washer placed between the bolt head and the DTI. Additional hardened or plate washer requirements are to be added under the DTI.

   d. Examination of Bolting:

1) Bolting inspection shall be visual and in accordance with the AISC Specification for Structural Joints.

2) Direct Tension Indicating Washers shall be compressed to an average gap equal to or less than 0.015". In all accessible, visible locations a visual inspection of the bolts should be adequate. The gap shall be checked with a metal feeler gauge for a minimum of 25 percent of the bolts in a connection, but no less than two bolts per connection selected at random.

3) When checking with the feeler gauge the space between all protrusions of the washer shall be checked, which for ¾" and 7/8" bolts shall be five (5) locations. The feeler gauge must not enter a minimum of three (3) spaces for the bolt tightening to be acceptable.

I. High-strength bolts shall not be reused after having been initially tightened. Retightening previously tightened bolts that have been loosened by the tightening of adjacent bolts is not considered as a reuse. Loosened or removed bolts that are not satisfactory for reuse shall be removed from the work area.

3.05 FIELD WELDING

A. All field welding shall be performed as indicated on the design and the erection drawings. Painted surfaces to be welded must be cleaned by grinding, wire brushing or shot blasting to remove the paint.

B. All welding shall be performed using written procedures in accordance with the AWS D1.1, Structural Welding Code. Welding procedures utilized shall be qualified in accordance with Section 5, Part A or B of AWS D1.1.

C. All welders shall be qualified by test, using the welding process to be used, before welding on structures covered by this section. The qualification of welders shall be conducted in accordance with AWS D1.1, Part C.

D. The Shielded Metal Arc Welding (SMAW) process shall be used for all structural welding. The filler metal shall be in accordance with AWS A5.1, classification E7018 covered electrode.

E. All complete joint penetration groove welds that are not double-sided weld joints shall be made with the use of carbon steel backing bars.

F. Surfaces and edges that are to be welded shall be smooth, uniform and free from fins, tears, cracks, paint, contaminants or other defects that would adversely affect the quality or strength of the weld.

G. Welds made by procedures that are not pre-qualified or have not been properly qualified shall be rejected.

3.06 FIELD CORRECTIONS

A. Field corrections of misfabricated members and misfits shall be made in accordance with the requirements herein and of the AISC. Details on the erection drawings that are in conflict with the design drawings shall be referred to the Fermilab Construction Coordinator for resolution.

B. All field holes, as well as any out-of-tolerance holes shall be drilled or reamed. Burning of holes shall not be allowed.

C. Mis-aligned holes shall be reamed to a diameter 1/16” greater than the nominal diameter of the bolt hole. Hardened washers shall be installed under both the bolt head and the nut when the misalignment exceeds 1/16” in Misalignment of holes greater than 3/16” shall be reported to the Fermilab Construction Coordinator for corrective action.

3.07 FIELD INSPECTION

A. Inspection of bolted assemblies shall be visual in accordance with Paragraph 1.06.

B. Completed weld joints shall be visually inspected in accordance with Paragraph 1.06. Slag shall be removed from all completed welds and the adjacent base metal shall be cleaned by brushing or other suitable means before inspection.

C. NDE shall be performed on welded structural joints as noted on the drawings and as specified in Part 1 and shall be in accordance with AWS D1.1, Section 6.

3.08 CLEAN-UP

A. All damaged steel areas and areas left uncoated for welding or bolting shall be field painted with the proper primer and topcoat material supplied. Painting shall be in accordance with the Steel Structures Painting Council (SSPC) Painting Manual and application guidelines, along with the manufacturer's instructions.

B. All areas to be field painted shall be wire brushed and power tool cleaned to remove all contaminants.

C. After completion of work of this section, remove from job-site all debris, tools and equipment of this trade.

END OF SECTION 05120

SECTION 05320 - METAL DECK

PART 1. GENERAL

1.01 SCOPE OF WORK

A. Metal roof deck.

B. Accessories.

1.02 RELATED WORK: The following sections prescribe items of related work. Coordinate work prescribed by this section with work prescribed.

A. Section 03100 - Concrete Forms and Accessories.

B. Section 03200 - Construction Reinforcement.

C. Section 05120 - Structural Steel.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. AISI - Specification for the Design of Cold-Formed Steel Structural Members.

B. ASTM A36 – Standard Specification for Carbon Structural Steel.

C. ASTM A653 – Standard Specifications for Steel Sheet, zinc-coated (galvanized) or zinc-iron alloy-coated (galvanized) by the hot-dip process.

D. AWS D1.1 - Structural Welding Code.

E. AWS D1.3 – Structural Welding Code – Sheet Steel.

F. SDI - Design Manual for Composite Decks, Form Decks and Roof Decks.

1.04 SUBMITTALS

A. Shop Drawings

1. Submit in accordance with provisions of Exhibit A, Section 12.0 - Submittals, Shop Drawings and Material Samples.

2. Deck layout, framing and supports with unit dimensions and sections.

3. Type and location of fasteners.

B. Manufacturer's Literature - recommended installation instructions.

C. Manufacturer's certificate that decking passes 100 hour salt spray test, Method 6061, FED-STD 141.

1.05 SYSTEM DESCRIPTION

A. Performance Requirements:

1. ANSI / SDI-RD1.0 “Standard” for steel roof deck.

2. Maximum unit design stress - 0.6 x minimum yield strength of steel.

3. Maximum yield working stress - 33,000 psi (roof deck).

4. Maximum deflection under live load: 1/240 span length, center to center of supports.

5. Roof deck anchorage to resist gross uplift loading: 30 psf less deck self weight.

B. Tolerances:

1. Panel Length: Plus or minus ½”.

2. Thickness: Shall not be less than 95 percent of the design thickness.

3. Panel Cover Width: Minus 3/8”, plus ¾”.

4. Panel Camber and/or sweep: ¼” in 10’ length.

5. Panel end out of square: 1/8” per foot of panel width.

1.06 QUALIFICATIONS

A. Manufacturer: Regularly engaged in the production of metal form and roof decking.

B. Erector: Minimum of five (5) years documented experience on comparable form and roof deck projects.

1.07 QUALITY ASSURANCE: Regulatory Requirements - Install metal deck to meet requirements of Steel Deck Institute.

1.08 DELIVERY, STORAGE AND HANDLING - Metal Decking

A. Do not bend or mar decking.

B. Store off ground with one end elevated for drainage.

C. Cover deck with waterproof material.

PART 2. PRODUCTS

2.01 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with “SDI Specifications and Commentary for Steel Roof Deck,” in SDI Publication No. 31, and with the following:

1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 zinc coated.

2. Deck Profile: As indicated.

3. Profile Depth: As indicated.

4. Design Uncoated-Steel thickness: As indicated.

5. Span Condition: As indicated.

6. Side Laps: Overlapped.

2.02 MATERIALS

B. Sheet Steel – Floor and Roof Decking: ASTM A653, Grade A structural quality.

C. Bearing Plates: ASTM A36 steel.

D. Welding Materials: AWS D1.1.

PART 3. EXECUTION

3.01 INSPECTION

A. Inspect supporting members for correct layout and alignment.

B. Verify that surfaces to receive deck are free of debris.

C. Do not proceed with installation until defects are corrected.

3.02 INSTALLATION

A. Erect metal decking in accordance with SDI Design manual for Composite Decks, Form Decks and Roof Decks. Provide welding in accordance with AWS D1.1.

B. On steel support members, provide 2” minimum bearing. Align and level on supports.

C. Fasten deck to supporting members with nominal 5/8 in. puddle welds in configurations indicated in drawing or, if not indicated, in sufficient number to provide a maximum average spacing of 12 in. The maximum spacing between points of attachment shall not exceed 18 in. Any fastener found to be defective shall be replaced.

D. Mechanically fasten male/female side laps per deck manufacturer’s requirements, at indicated spacing, or, if not indicated, at all supports and at mid-span.

E. Install sheet metal closures and angle flashings to close openings between deck and walls and openings.

3.03 PROTECTION

A. Do not use deck units for storage or working platforms until permanently secured in position.

B. Assure that construction loads do not exceed carrying capacity of deck.

END OF SECTION 05320

SECTION 05500-METAL FABRICATIONS

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Extent of metal fabrications work is shown on the drawings and includes items fabricated from steel shapes, plates, bars, strips, tubes, pipes and castings which are not part of the structural steel or other metal systems in other sections of these specifications.

B. Metal fabrications items include, but are not limited to the following:

1. Bolts, anchors and fasteners.
2. Carpenter's iron work.
3. Miscellaneous framing and supports.
4. Miscellaneous steel trim.
5. Metal ladders and ladder safety cages.
6. Shaft and Hatch covers.
7. Steel framed canopy.
8. Track plates, pull plates and setting grout.
9. Embedded steel shapes and headed stud anchors.
10. Embedded Channel Inserts.
11. Carbon Steel buried air ducts.

1.02 REFERENCE TO STANDARDS

A. ASTM A36 - Structural Steel.

B. ASTM A53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.

C. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated From Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip.

D. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

E. ASTM A786 – Hot Rolled Steel Floor Plate.

F. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure and Other Special Purpose Applications.

G. ASTM A307 - Carbon Steel Externally Threaded Standard Fasteners.

H. ASTM A325 - High Strength Bolts for Structural Steel Joints.

I. ASTM A386 - Zinc-Coating (Hot-Dip) on Assembled Steel Products.

J. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

K. AWS A2.0 - Standard Welding Symbols.

L. AWS D1.1 - Structural Welding Code.

M. SSPC - Steel Structures Painting Council.

N. AISI 304 - Stainless Steel Fasteners, Nuts and Washers.

1.03 SUBMITTALS

A. Submit under the provisions of Exhibit A, Section 12.0 - Submittals, Shop Drawings and Material Samples.

B. Submit shop drawings for fabrication and erection of miscellaneous metal assemblies. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others.

C. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld strengths.

D. Product Data: Submit manufacturer’s specifications, anchor details and installation instructions for products to be used in fabrication of miscellaneous metal work, including paint products. Indicate by transmittal that copy of instructions has been distributed to installer.

1.04 QUALITY ASSURANCE

A. Field Measurements:

1. Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting wherever taking field measurements before fabrication might delay work.

B. Inserts and Anchorages:

1. Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of metal work. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

2. See concrete, mechanical, electrical and other sections of these specifications for installation of inserts and anchorage devices.

C. Shop Assembly:

1. Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary to shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

D. Codes and Standards:

1. Comply with the provisions of the following codes, standards and specifications, except as otherwise shown and specified:

a) AISC – “Specification for Structural Steel Buildings” (ANSI/AISI 360-05), and including “Commentary on the Specification for Structural Steel Buildings.”

b) AISI - “Specification for the Design of Cold-Formed Steel Structural Members.”

c) AWS - “Code for Welding in Building Construction.”

d) ASTM A6 - “General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.”

E. AISC Qualification for Welding Work:

1. Qualify welding processes and welding operators in accordance with AWS “Standard Qualification Procedure.”

PART 2. PRODUCTS

2.01 MATERIALS

A. Steel Plates, Shapes and Bars: ASTM A36.

B. Steel Tubing (HSS Sections): ASTM A500, Grade B.

C. Pipe: ASTM A53, Grade B, Type S, Schedule 40 (Exterior).

D. Pipe: ASTM A53, Grade B, Type S. Schedule 80 (Interior).

E. Fasteners: ASTM A307, unless noted otherwise.

F. Threaded bars and accessories anchors for embedded channels shall be the Threadbar Reinforcing Systems as manufactured by Dywidag Systems International or approved equal, Grade 60 KSI.

G. Embedded channel Inserts, Unistrut Corporation's 3200 Series, pre galvanized conforming to ASTM A653 GR 33, with closure strip, and end plates or approved equal.

H. Bolts, Nuts, and Washers: ASTM A307, unless noted otherwise.

I. High-Strength Threaded Fasteners: ASTM A325, ¾" diameter (minimum), unless noted otherwise.

J. Welding Materials: AWS D1.1; type required for materials being welded.

K. Touch-Up Paint: ZRC Galvalite Cold Galvanizing Compound, or equal.

L. Bitumastic Paint for all steel elements below grade and exposed to earth shall be Carboline Bitumastic 50 or approved equal.

M. Cathartic protection: all steel element below grade, and exposed to earth, shall have a minimum 17 pounds anode affixed to the buried steel or as specified in specification section 02510, Utilities, Part 2, 2.01G.

N. Drilled-In Anchors:

1. All drilled-in concrete anchors shall be adhesive capsule anchor type or expansion anchor type, as manufactured by Hilti, or approved equal. Use of expansion anchor devices shall be permitted only where shown on the drawings and where required for attachment of miscellaneous equipment. There will be no exceptions to this requirement. Drilled-in anchors shall be a minimum of ½" diameter, unless noted otherwise, with minimum embedment as required by manufacturer, or shown on the drawings.

O. Grating over base slab trenches shall be Aluminum Plank Grate, unpunched, 2 ½" deep by 6" wide, Heavy Duty-Plain Sides as manufactured by Interstate Grating or approved equal.

2.02 FASTENERS

A. General:

1. Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for type, grade and class required. Stainless steel fasteners shall be used where exposed to earth.

B. Bolts and Nuts:

1. Regular hexagon head type, ASTM A307, Grade A or ASTM A325 bolts.

2. Regular hexagon or square type, ASTM A563 nuts.

C. Lag Bolts:

1. Square head type, FS FF-B-561.

D. Machine Screws:

1. Cadmium plated steel, FS-FF-S-92.

E. Wood Screws:

1. Flat head carbon steel, FS-FF-S-111.

F. Plain Washers:

1. Round, carbon steel, FS FF-W-92.

G. Lock Washers:

1. Helical spring type carbon steel, FS FF-W-84.

2.03 FINISH

A. All steel shapes, plates, bars, strips and assemblies shall be primed and painted with two finish coats.

B. Structural steel, joists and miscellaneous steel:

1. Prior to delivery and erection abrasive blast in accordance with SSPC-SP6. Blast profile shall be compatible with primer paint.

2. Immediately after blasting (same day) paint with prime coat as indicated.

2.04 FABRICATION - GENERAL

A. Workmanship:

1. Use materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in finished product. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for various components of work.

2. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32” unless otherwise shown. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

3. Weld corners and seams continuously, complying with AWS recommendations. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces. All welds shall be made with E70XX electrodes and shall conform to AWS Specifications.

4. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type shown or, if not shown, Phillips flat-head (countersunk) screws or bolts.

5. Provide for anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices as shown and as required to provide adequate support for intended use.

6. Cut, reinforce, drill and tap miscellaneous metal work as required to provide adequate support for intended use.

7. Cut, reinforce, drill and tap miscellaneous metal work as required to receive finish hardware and similar items.

8. Use hot-rolled steel bars for work fabricated from bar stock, unless shown or specified to be fabricated from cold-finished or cold-rolled stock.

9. Verify dimensions on site prior to shop fabrication.

10. Fabricate items with joints tightly fitted and secured.

11. Fit and shop assemble in largest practical sections, for delivery to site.

12. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.

13. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of structure, except where specifically noted otherwise.

14. Supply components required for anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

15. Paint Primer - Provide shop applied prime coat in accordance with Section 09900 - Painting.

2.05 STEEL LADDERS AND CAGES:

A. Comply with ANSI A14.3, unless otherwise indicated.

B. Space siderails 18” apart, unless otherwise indicated.

C. Support each ladder at top and bottom and not more than 48” o.c. with welded or bolted brackets, made from same metal as ladder.

D. Siderails: Continuous, ½” x 2 ½ ” steel flat bars, with eased edges.

E. Rungs: 1” diameter steel bars

F. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.

G. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.

H. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically boned to rung by a proprietary process.

I. Galvanize exterior, including brackets and fasteners.

2.06 MISCELLANEOUS METAL ITEMS

A. Carpenter’s Iron Work:

1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware are specified in Division 6 Sections.

2. Manufacture or fabricate items of sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

B. Miscellaneous Steel Trim:

1. Provide shapes and sizes as required for profiles shown. Except as otherwise noted, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other work:

a) Galvanize miscellaneous steel trim where indicated.

2.07 ANCHOR BOLTS AND ADHESIVE ANCHORS

A. All steel anchor bolts shall be as detailed on the plans and shall be ASTM A 1554 Gr. 36, with hardened washers and standard nuts, all shall be Hot Dip Galvanized.

B. All adhesive anchors in exposed and/or exterior conditions shall consist of Type 304 stainless steel rods and an adhesive cartridge. All other adhesive anchors shall consist of A193 rods and an adhesive cartridge. All adhesive anchors shall be Hilti HAS Anchor Rod Assembly with Hilti HBP Adhesive Cartridge, EPCON Epoxy Anchoring System from ITW, or equal. Expansion anchors will not be permitted under any circumstance where adhesive anchors are indicated.

2.08 TRACK AND PULL PLATES

A. Plates shall conform to ASTM A36.

B. Tolerances: the track plates and pull plates shall be furnished with a flatness tolerance of .125” over a 12’ length. If necessary, a press shall be used to achieve this flatness. Matching ends of plates are to be parallel and perpendicular to the length of the plate. If required, mill the ends of the plates to achieve this squareness. If the plates are bowed, fabricate with the bow up.

C. Fill all of the holes, except the grout holes, with cosmoline grease and cover with a 1/8” cap plate before shipping.

2.09 GROUT FOR TRACK AND PULL PLATES

A. Grout shall be a non-shrink/non-bleed grout. Grout shall have a minimum 28 day compressive strength of 7000 psi with a flow cone consistency of 25 seconds ± 5 seconds. Acceptable grouts are “Crystex” by L&M Construction Chemicals, Masterflow 928 by Master Builders or an approved equal.

PART 3. EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

B. Beginning of installation means erector accepts existing conditions.

3.02 PREPARATION

A. Furnish setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Obtain Construction Coordinator approval prior to site cutting or making adjustments not scheduled.

C. Clean and strip steel items to bare metal where site welding is scheduled.

D. Make provisions for erection loads with temporary bracing. Keep work in alignment.

E. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate sections.

3.03 INSTALLATION

A. Fastening to In-Place Construction:

1. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

B. Cutting, Fitting and Placement:

1. Perform cutting, drilling and fitting required for installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.

C. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up shop paint coat or galvanized finish.

D. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

E. Field weld components indicated on Drawings.

F. Embedded channel inserts shall be set flush with concrete face and shall be free of concrete and debris including any nails used to attach to forms.

G. Perform field welding in accordance with AWS D1.1.

H. Obtain Construction Coordinator approval prior to site cutting or making adjustments not scheduled.

I. Immediately after erection, clean field welds, bolted connections and abraded areas and touch up with 6 mils of cold galvanizing compound.

3.04 ERECTION TOLERANCES

A. Deviation from plumb, level and alignment shall not exceed one (1) in five hundred (500).

3.05 TRACK AND PULL PLATES

3.06 A. PLANNING: Submit a written work plan with the steel plate submittal which outlines the plate selection, fabrication, installation, welding, survey, leveling and grouting procedures.

B. Carefully align and level the top surface of the track and pull plates at the joints to ± 1/16” of the elevation shown on the drawings. Scribe the plates for proper alignment.

C. The accumulation of the mill tolerances and the fabrication tolerances shall not cause the erection tolerances to be exceeded. Erection tolerances for the plates are plus or minus 3/16” to the established grade and plus or minus 1/8” to the prescribed line based on the plate centerline.

D. Grouting Instructions:

I. Surface preparations: Clean surfaces of oil, grease, dirt and mechanically roughen the concrete surface removing the laitance down to sound concrete in the area to be grouted. Abrasive blast the steel plates to commercial grade SP-6 and coat with a lead and chromate free rust-inhibitive clear epoxy paint or primer. Saturate the clean surfaces with water. Remove all standing water prior to grouting.

II. Forms: to facilitate continuous and complete filling of space, forms must be strong and tight to prevent leaking. Maintain full contact of grout with plate and base mat until it hardens.

III. Mixing: Set up mixing adjacent to grouting area. Grout shall be mixed in a mixer to a smooth consistency. Placing of the grout shall be done by a grout pump or damp packing.

IV. Temperature: Avoid storing grout in extreme temperature areas; i.e., warm storage in cold weather and cool storage in hot weather. Mixing and placing is to be done in the 45° F to 70° F temperature range. Keep base mat, plates and grout above 40° F for at least 24 hours after placement.

V. Curing: Cover all exposed grout with wet rags immediately after placing.

VI. Precautions: Grout is cement based. Follow ACI practices for storing, mixing, placing and curing concrete in hot or cold weather. Do not add cement or plasticizer to grout. Avoid mixing more grout than can be placed within manufacturer's recommended time. Avoid grout placement when temperatures are or will be below 40° F (4° C) within 24 hours. Rapid and continuous mixing and placing are necessary on large pours. Avoid excessive vibration of plates at time of placement and for a period of 48 hours. It is the Subcontractor's responsibility to follow the recommendations of the manufacturer to insure a proper job.

END OF SECTION 05500

SECTION 05510 - METAL STAIRS

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with concrete-filled treads

2. Steel tube railings attached to metal stairs.

3. Steel tube handrails attached to walls adjacent to metal stairs.

B. See Section 05521 “Pipe and Tube Railings” for pipe and tube railings not attached to metal stairs or to walls adjacent to metal stairs.

1.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft

2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.

3. Uniform and concentrated loads need not be assumed to act concurrently.

4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

5. Limit deflection of treads, platforms, and framing members to L/240 or ¼”, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

a) Uniform load of 50 lbf/ ft. applied in any direction.

b) Concentrated load of 200 lbf applied in any direction.

c) Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a) Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

b) Infill load and other loads need not be assumed to act concurrently.

1.03 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Prefilled metal-pan stair treads

2. Abrasive nosings

3. Paint products

B. Welding certificates.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified structural engineer responsible for their preparation. Stair designer shall be a licensed Structural Engineer licensed in the state of Illinois.

1.04 QUALITY ASSURANCE

A. NAAMM Stair Standard: Comply with “Recommended Voluntary Minimum Standards for Fixed Metal Stairs” in NAAMM AMP 510, “Metal Stairs Manual,” for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Service class.

PART 2. PRODUCTS

2.01 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.

2.02 ABRASIVE NOSINGS

A. Extruded Units: Aluminum units with abrasive filler in an epoxy-resin binder.

1. Basis of Design Product: Subject to compliance with requirements, provide Supergrit Profile type 121BF (1-7/8” wide) safety treads/nosings as manufactured by Wooster Products Inc. or comparable product by one of the following:

   a) American Safety Tread Co., Inc.

   b) Balco Inc.

   c) Granite State Casting Co.

   d) Safe-T-Metal Company, Inc.

2. Provide ribbed units, with abrasive filler strips projecting 1/16” above aluminum extrusion.

3. Provide solid-abrasive-type units without ribs.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

D. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.03 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.

2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without impairing work.

E. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Weld exposed corners and seams continuously unless otherwise indicated.

5. At exposed connections, finish exposed welds to comply with NOMA's "Voluntary Joint Finish Standards" for 2 welds: completely sanded joint, some undercutting and pinholes okay.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

G. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.04 STEEL-FRAMED STAIRS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alfab, Inc.

2. American Stair, Inc.

3. Sharon Companies Ltd. (The).

B. Stair Framing:

1. Fabricate stringers of steel plates or channels.

2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.

3. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.

4. Where stairs are enclosed by gypsum board or shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below.

5. Where stairs are enclosed by masonry walls, provide hanger rods or struts to support landings from floor construction or steel framing members above or below.

6. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067”.

1. At Contractor’s option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.

2.05 STAIR RAILINGS

A. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: 1-½" outside-diameter top and bottom rails and 1-½"-outside-diameter posts.

2. Picket Infill: As indicated on the drawings spaced less than 4" clear.

3. Intermediate Rails Infill: 1-½"-outside-diameter intermediate rails spaced less than 21" clear.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Finish welds to comply with NOMA's "Voluntary Joint Finish Standards" for Type 2 welds: completely sanded joint, some undercutting and pinholes okay, grind all welds smooth.

C. Form changes in direction of railings by bending or by inserting prefabricated elbow fittings.

D. Form curves by bending members in jigs to produce uniform curvature without buckling.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Connect posts to stair framing by direct welding.

2.06 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Stairs and railings to be field painted in accordance with Section 9900.

PART 3. EXECUTION

3.01 INSTALLATION

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.

C. Field Welding: Comply with requirements for welding in “Fabrication, General” Article.

D. Place and finish concrete fill for treads and platforms to comply with Section 033000 “Cast-in-Place Concrete.”

1. Install abrasive nosings with anchors fully embedded in concrete.

E. Attach handrails to wall with wall brackets. Use type of bracket with predrilled hole for exposed bolt anchorage.

3.02 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

END OF SECTION 05510

SECTION 05521 - PIPE AND TUBE RAILINGS

PART 1. GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Steel pipe and tube railings for elevated walkway areas and where indicated on plans.

2. Wall mounted handrail for concrete stairs

B. Related Sections include the following:

1. Division 5 Section “Metal Stairs” for steel tube railings associated with metal stairs.

1.02 PERFORMANCE REQUIREMENTS

A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Steel: 72 percent of minimum yield strength.

B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails:

a) Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.

b) Concentrated load of 200 lbf (0.89 kN) applied in any direction.

c) Uniform and concentrated loads need not be assumed to act concurrently.

2. Top Rails of Guards:

a) Uniform load of 50 lbf/ ft. (0.73 kN/m) applied horizontally and concurrently with 100 lbf/ ft. (1.46 kN/m) applied vertically downward.

b) Concentrated load of 200 lbf (0.89 kN) applied in any direction.

c) Uniform and concentrated loads need not be assumed to act concurrently.

3. Infill of Guards:

a) Concentrated load of 200 lbf (0.89 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).

b) Uniform load of 25 lbf/sq. ft. (1.2 kN/sq. m) applied horizontally.

c) Infill load and other loads need not be assumed to act concurrently.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.03 SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.

2. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified structural engineer responsible for their preparation.

C. Samples for Verification: For each type of exposed finish required.

D. Welding certificates.

E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."

1.05 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

2. Provide allowance for trimming and fitting at site.

1.06 COORDINATION AND SCHEDULING

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

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Steel Pipe and Tube Railings:

a) Pisor Industries, Inc.

b) Sharpe Products.

c) Wagner, R & B, Inc.; a division of the Wagner Companies.

2.02 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.03 STEEL AND IRON

A. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).

B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Castings: Either gray or malleable iron, unless otherwise indicated.

1. Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.

2. Malleable Iron: ASTM A 47/A 47M.

2.04 FASTENERS

A. General: Provide the following:

1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. Anchors: Provide cast-in-place, chemical or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 9 painting Sections.

C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a) Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.

b) Carboline Company; Carbozinc 621.

c) ICI Devoe Coatings; Catha-Coat 313.

d) International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.

e) PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.

f) Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.

g) Tnemec Company, Inc.; Tneme-Zinc 90-97.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.06 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32” (1 mm), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

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

G. Connections: Fabricate railings with welded connections, unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer’s standard splicing method.

J. Form changes in direction as follows:

1. By bending or by inserting prefabricated elbow fittings.

K. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

M. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is ¼” (6 mm) or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

P. For railing posts set in concrete, provide steel sleeves not less than 6” (150 mm) long with inside dimensions not less than ½” (13 mm) greater than outside dimensions of post, with steel plate forming bottom closure.

Q. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.07 FINISHES, GENERAL

A. Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.08 STEEL AND IRON FINISHES

A. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

B. Preparation for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface

preparation specifications and environmental exposure conditions of installed railings:

1. Interior Railings Indicated to Receive Zinc-Rich Primer (SSPC Zone 1A): SSPC-SP 6/NACE No. 3, “Commercial Blast Cleaning.”

D. Apply shop primer to prepared surfaces of railings, unless otherwise indicated. Comply with requirements in SSPC-PA 1, “Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel,” for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

E. All railings to be painted in accordance with Section 09900.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16” in 3’ (2 mm in 1 m).

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed ¼” in 12’ (5 mm in 3 m).

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.03 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Part 2 “Fabrication” Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2” (50 mm) beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6” (150 mm) of post.

3.04 ANCHORING POSTS

A. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

3.05 ANCHORING RAILING ENDS

A. Anchor railing ends to concrete and masonry with round flanges connected to railing ends and anchored to wall construction with anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

3.06 ATTACHING HANDRAILS TO WALLS

A. Attach handrails to wall with wall brackets. Provide brackets with 1-½” (38-mm) clearance from inside face of handrail and finished wall surface.

1. Use type of bracket with predrilled hole for exposed bolt anchorage.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

2. For hollow masonry anchorage, use toggle bolts.

3.07 ADJUSTING AND CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

C. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.

3.08 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05521

SECTION 06100 - ROUGH CARPENTRY

PART 1. GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Wood blocking, cants and nailers.

2. Plywood wall panels in elevator machine room and mechanical room

B. Related Sections include the following:

1. Division 9 Section “Gypsum Board Assemblies”

2. Division 9 Section “Painting”

3. Division 10 Section “Toilet, Bath and Laundry Accessories”

1.02 DEFINITIONS

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2” nominal or greater but less than 5” nominal in least dimension.

C. Timber: Lumber of 5” nominal or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers’ Association.

2. NLGA: National Lumber Grades Authority.

3. RIS: Redwood Inspection Service.

4. SPIB: The Southern Pine Inspection Bureau.

5. WCLIB: West Coast Lumber Inspection Bureau.

6. WWPA: Western Wood Products Association.

1.03 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

C. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

D. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Wood-preservative-treated wood.

2. Fire-retardant-treated wood.

3. Power-driven fasteners.

4. Powder-actuated fasteners.

5. Expansion anchors.

6. Metal framing anchors.

1.04 QUALITY ASSURANCE

A. Source Limitations for Engineered Wood Products: Obtain each type of engineered wood product through one source from a single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2. PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece

3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

4. Provide dressed lumber, S4S, unless otherwise indicated.

B. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.02 PLYWOOD BACKING PANELS

A. Backing panels at inside of exterior wall: Fire retardant treated Standard grade plywood with exterior glue, not less than 5/8inch thick, primed and painted in accordance with Section 09900. Do not paint over FRT label.

2.03 FIRE-RETARDANT-TREATED MATERIALS

A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).

1. Use Exterior type for exterior locations and where indicated.

2. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.

3. Use Interior Type A, unless otherwise indicated.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

C. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

D. Application: Treat all rough carpentry, unless otherwise indicated.

2.04 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

2. Nailers.

3. Cants.

4. Furring.

B. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.05 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity,

provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

PART 3. EXECUTION

3.01 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA’s “Details for Conventional Wood Frame Construction,” unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.

E. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

F. Do not splice structural members between supports, unless otherwise indicated.

G. Provide blocking and framing as indicated on drawings and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16” o.c.

H. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.

2. Table 2304.9.1, “Fastening Schedule,” in ICC’s International Building Code.

3. Table 23-II-B-1, “Nailing Schedule,” and Table 23-II-B-2, “Wood Structural Panel Roof Sheathing Nailing Schedule,” in ICBO’s Uniform Building Code.

4. Table 2305.2, “Fastening Schedule,” in BOCA’s BOCA National Building Code.

5. Table 2306.1, “Fastening Schedule,” in SBCCI’s Standard Building Code.

K. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

L. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

1. Comply with approved fastener patterns where applicable.

2. Use finishing nails, unless otherwise indicated.

3.02 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-½" wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.03 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06100

SECTION 06160 - SHEATHING

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Wall sheathing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

PART 2. PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

2.02 WALL SHEATHING

A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.

1. Type and Thickness: Type X, 5/8" thick.

2.03 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For parapet wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M Or Epoxy coated fasteners.

2.04 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing

manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 “Joint Sealants.”

B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2” wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3. EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.

2. Table 2304.9.1, “Fastening Schedule,” in ICC’s “International Building Code.”

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.02 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer’s written instructions.

1. Fasten gypsum sheathing to cold-formed metal framing with screws.

2. Install boards with a 3/8” gap where non-load-bearing construction abuts structural elements.

3. Install boards with a ¼" gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.

2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 06160

SECTION 006412 – PLASTIC LAMINATE FACED ARCHITECTURAL CABINETS

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plastic-laminate-faced architectural cabinets.

2. Woodfurring, blocking, shims, and hanging strips for installing plastic-laminate-faced architectural cabinets unless concealed within other construction before cabinet installation.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product, including panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, fire-retardant-treated materials, and cabinet hardware and accessories

1.03 QUALITY ASSURANCE

A. Fabricator Qualifications: Member of AWI.

B. Installer Qualifications: Member of AWI.

1.04 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2. PRODUCTS

2.01 ARCHITECTURAL CABINET FABRICATORS

A. Fabricators: Subject to compliance with requirements, provide products by a qualified cabinet fabricator.

2.02 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the “Architectural Woodwork Standards” for grades of architectural plastic-laminate cabinets indicated for construction, finishes, installation, and other requirements.

B. Grade: Custom.

C. Type of Construction: Frameless.

D. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.

E. Reveal Dimension: ½”

F. High-Pressure Decorative Laminate: NEMA LD 3, grades as required by woodwork quality standard.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) Abet Laminati, Inc.

b) Formica Corporation.

c) Lamin-Art, Inc.

d) Panolam Industries International, Inc.

e) Wilsonart International; Div. of Premark International, Inc.

G. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.

2. Postformed Surfaces: Grade HGP.

3. Vertical Surfaces: Grade HGS

4. Pattern Direction: Vertically for doors and fixed panels, horizontally for drawer fronts.

H. Materials for Semi-exposed Surfaces:

1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.

3. Drawer Bottoms: Thermoset decorative panels.

I. Dust Panels: ¼” plywood or tempered hardboard above compartments and drawers unless located directly under tops.

J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer's designations.

    a) Solid colors, matte finish.

    b) Solid colors with core same color as surface, matte finish.

    c) Wood grains, matte finish.

    d) Patterns, matte finish.

2.03 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

    1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

    1. Medium-Density Fiberboard: ANSI A208.2, Grade 130

    2. Particleboard: ANSI A208.1, Grade M-2

C. Softwood Plywood: DOC PS 1, medium-density overlay.

2.04 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

    1. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5' beyond the centerline of the burners at any time during the test.

    1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

2.05 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087111 “Door Hardware (Descriptive Specification).”

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening, self-closing.

C. Wire Pulls: Back mounted, solid metal, 4” long, 5/16” in diameter.

D. Adjustable Shelf Standards and Supports: Knape and Vogt 255 and 256 or approved equal

E. Drawer Slides: BHMA A156.9: Grade 1HD-100: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.

F. Door Locks: BHMA A156.11, E07121.

G. Drawer Locks: BHMA A156.11, E07041.

H. Door and Drawer Silencers: BHMA A156.16, L03011.

I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin or brushed Stainless Steel: BHMA 630.

2.06 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesives: Do not use adhesives that contain urea formaldehyde.

D. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.

2. Contact Adhesive: 250 g/L.

2.07 FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3. EXECUTION

3.01 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

3.02 INSTALLATION

A. Grade: Install cabinets to comply with same grade as item to be installed.

B. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8” in 96”.

C. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

D. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.

E. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

F. Install cabinets with no more than 1/8” in 96” sag, bow, or other variation from a straight line.

END OF SECTION 06412

SECTION 006417 – PLASTIC LAMINATE CLAD COUNTERTOPS

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes plastic-laminate countertops.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples:

1. Plastic laminates, for each color, pattern, and surface finish.

1.03 QUALITY ASSURANCE

A. Fabricator Qualifications: Member of AWI.

B. Installer Qualifications: Fabricator of products.

1.04 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2. PRODUCTS

2.01 PLASTIC-LAMINATE COUNTERTOPS

A. Quality Standard: Unless otherwise indicated, comply with the “Architectural Woodwork Standards” for grades indicated for construction, installation, and other requirements.

B. Grade: Custom.

C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) Abet Laminati, Inc.

b) Formica Corporation.

c) Lamin-Art, Inc.

d) Panolam Industries International, Inc.

e) Wilsonart International; Div. of Premark International, Inc.

D. Chemical-Resistant, High-Pressure Decorative Laminate: NEMA LD 3, Grade HGP, and as follows:

1. Laminate has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.9.5:

a) Nitric Acid (30 Percent): Moderate effect.

b) Sulfuric Acid (77 Percent): Moderate effect.

c) Hydrochloric Acid (37 Percent): Moderate effect.

d) Phosphoric Acid (75 Percent): No effect.

e) Acetic Acid (98 Percent): No effect.

f) Formaldehyde: No effect.

g) Ethyl Acetate: No effect.

h) Ethyl Ether: No effect.

i) Phenol (85 Percent): Moderate effect.

j) Benzene: No effect.

k) Xylene: No effect.

l) Butyl Alcohol: No effect.

m) Furfural: No effect.

n) Methyl Ethyl Ketone: No effect.

o) Sodium Hydroxide (25 Percent): No effect.

p) Sodium Sulfide (15 Percent): No effect.

q) Ammonium Hydroxide (28 Percent): No effect.

r) Zinc Chloride: No effect.

s) Gentian Violet: No effect.

t) Methyl Red: No effect.

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a) Formica Corporation; Lab Grade 840 Black.

b) Panolam Industries International, Inc.; Pionite Chemguard.

c) Wilsonart International, Div. of Premark International, Inc.; Chemsurf.

E. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated on drawings by manufacturer's designations.

F. Edge Treatment: Same as laminate cladding on horizontal surfaces

G. Core Material at Sinks: Particleboard made with exterior glue or exterior-grade plywood.

H. Core Thickness: ¾".

1. Build up countertop thickness to 1-½" at front, back, and ends with additional layers of core material laminated to top.

I. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

2.02 MISCELLANEOUS MATERIALS

A. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.03 FABRICATION

A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1" over base cabinets. Ease edges.

B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

C. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of openings in countertops with a coat of varnish.

PART 3. EXECUTION

3.01 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

3.02 INSTALLATION

A. Grade: Install countertops to comply with same grade as item to be installed.

B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items.

2. Seal edges of cutouts by saturating with varnish.

C. Field Jointing: Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required.

1. Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6” of front and back edges and at intervals not exceeding 24”. Tighten according to manufacturer’s written instructions to exert a constant, heavy-clamping pressure at joints.

D. Install countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8” in 96”.

E. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

F. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Install countertops with no more than 1/8” in 96” sag, bow, or other variation from a straight line.

2. Secure backsplashes to tops with concealed metal brackets at 16” o.c. and to walls with adhesive.

3. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

END OF SECTION 06417

SECTION 07115 – BITUMINOUS DAMPPROOFING

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes cold-applied emulsified-asphalt dampproofing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2. PRODUCTS

2.01 MATERIALS, GENERAL

A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.02 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPROOFING

A. Basis of Design Product: Subject to compliance with requirements, provide Short-fiber Fibrated Product: Hydrocide 700B cold-applied waterborne emulsified-asphalt dampproofing as manufactured by BASF Construction Chemicals - Building Systems; Sonneborn Brand Products, or comparable product by one of the following:

1. APOC, Inc.; a division of Gardner-Gibson.
2. Brewer Company (The).
3. ChemMasters, Inc.
4. Euclid Chemical Company (The); an RPM company.
5. Gardner-Gibson, Inc.
6. Koppers Inc.
7. Malarkey Roofing Products.
8. Meadows, W. R., Inc

B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

C. VOC Content: 30 g/L or less.

2.03 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

PART 3. EXECUTION

3.01 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for substrate preparation, dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.

1. Apply dampproofing to provide continuous plane of protection.

2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from a line 6 inches above finished-grade to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.

1. Extend dampproofing 12” onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.

2. Extend dampproofing up to 6 inches above finished grade, providing a straight line parallel to finished grade line.

3. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as “reinforced,” by embedding an 8” wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing interior face of above-grade, exterior concrete walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls:

3.02 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat, one fibered brush or spray coat at not less than 3 gal./100 sq. ft., or one trowel coat at not less than 4 gal./100 sq. ft..

B. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft.

C. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft.

3.03 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

END OF SECTION 07115

SECTION 07131 – SELF-ADHERING SHEET WATERPROOFING

PART 1. GENERAL

1.01 SUMMARY

A. Section includes self-adhering modified bituminous sheet waterproofing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.03 INFORMATIONAL SUBMITTALS

A. Product Data

B. Sample warranties.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.05 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Verify available warranties and warranty periods.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: Minimum 60-mil nominal thickness, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. American Hydrotech, Inc.; VM75.

2. Carlisle Coatings & Waterproofing Inc.; CCW MiraDRI 860/861.

3. CETCO Building Materials Group, a subsidiary of AMCOL International Corp.; Envirosheet.

4. Grace, W. R., & Co. - Conn.; Bituthene 4000.

5. Henry Company; Blueskin WP 100/200.

6. Meadows, W. R., Inc.; SealTight Mel-Rol.

7. Nervastral, Inc.; BITU-MEM.

8. Polyguard Products, Inc.; Polyguard 650.

9. Protecto Wrap Company; PW 100/60.

10. Tamko Building Products, Inc.; TW-60.

11. York Manufacturing, Inc.; HydroGard.

12. Physical Properties:

a) Tensile Strength, Membrane: 250 psi minimum; ASTM D 412, Die C, modified.

b) Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.

c) Low-Temperature Flexibility: Pass at minus 20 deg F ASTM D 1970.

d) Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.

e) Puncture Resistance: 40 lbf minimum; ASTM E 154.

f) Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F ASTM D 570.

g) Water Vapor Permeance: 0.05 perms maximum; ASTM E 96/E 96M, Water Method.

h) Hydrostatic-Head Resistance: 150 feet minimum; ASTM D 5385.

13. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.02 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne primer recommended for substrate by sheet-waterproofing material manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

F. Metal Termination Bars: Aluminum bars, approximately 1 x 1/8” thick, predrilled at 9” centers.

PART 3. EXECUTION

3.01 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

A. Prepare surfaces and install modified bituminous sheets according to waterproofing manufacturer’s written instructions and recommendations in ASTM D 6135.

B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-½” minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.

D. When ambient and substrate temperatures range between 25° and 40° F install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60° F.

E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

F. Seal edges of sheet-waterproofing terminations with mastic. Provide continuous termination bar at grade level, mechanically fastened to concrete foundation walls.

G. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.

H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6” beyond repaired areas in all directions.

I. Immediately install protection course with butted joints over waterproofing membrane.

3.02 PROTECTION, REPAIR, AND CLEANING

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07131

SECTION 07180 – TRAFFIC COATINGS

PART 1. GENERAL

1.01 SUMMARY

A. Section includes Traffic Coatings for the following applications:

1. Floor Covering.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product, including installation instructions.

B. Shop Drawings: For traffic coatings.

1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.

C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.06 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace traffic coating that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 MATERIALS, GENERAL

A. Material Compatibility: Provide primers; base-, intermediate-, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.02 TRAFFIC COATING:

A. Basis of Design: The below listed product serves as the basis of design. Equal products from other manufacturers may be considered for substitution.

B. Traffic Coating: 100 percent solids, two component epoxy floor coating specially designed for use as a protective coating.

1. Manufacturers: Provide products by the following:

a) Benjamin Moore & Co.

2. Product: Super Spec HP, 100% Solids Floor Epoxy P40.

C. Primer: Liquid primer recommended for substrate and conditions by traffic-coating manufacturer.

D. First and Second Coat: Super Spec HP P40, color: Gray.

E. Anti-slip Aggregate: Super Spec HP Anti-slip Aggregate (P67).

2.03 ACCESSORY MATERIALS

A. Joint Sealants: As specified in Section 07901 “Joint Sealants.”

B. Sheet Flashing: Non-staining sheet material recommended in writing by traffic-coating manufacturer.

C. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.

PART 3. EXECUTION

3.01 PREPARATION

A. General: Clean and prepare substrates according to ASTM C 1127 and manufacturer’s written instructions to produce clean, dust-free, dry substrate for traffic-coating application.

1. Application of coating indicates acceptance of surfaces and conditions.

B. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.

C. Concrete Substrates: Mechanically abrade surface, by either grinding or shot-blasting, to a uniform profile acceptable to manufacturer, according to ASTM D 4259. Do not acid etch.

1. Remove grease, oil, paints, and other penetrating contaminants from concrete.

2. Remove concrete fins, ridges, and other projections.

3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.

4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

3.02 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written instructions.

B. Provide sealant cants at penetrations and at reinforced and non-reinforced, deck-to-wall butt joints.

C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.

D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer’s written recommendations.

3.03 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer’s written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

3.04 TRAFFIC-COATING APPLICATION

A. Apply traffic coating according to ASTM C 1127 and manufacturer's written instructions.

B. Apply number of coats of specified compositions for each type of traffic coating at locations as indicated on Drawings. Minimum total dry film thickness of 16 mils, applied in two coats.

C. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.

D. Anti-slip aggregate: Within 30 minutes after applying the first coat, hand broadcast the Anti-slip aggregate into the first coat, taking care to leave 12" unsanded area on each edge for the next batch to overlap. Wearing spiked shoes, lightly back roll the aggregate into the coating so it is encapsulated.

E. Cure traffic coatings.

3.05 PROTECTING AND CLEANING

A. Protect traffic coatings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07180

SECTION 07210 - BUILDING INSULATION

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Foam-plastic board insulation – Rigid board foundation insulation.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2. PRODUCTS

2.01 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) DiversiFoam Products.

b) Dow Chemical Company (The).

c) Owens Corning.

d) Pactiv Building Products.

2. Type IV, 25 psi.

3. Thickness: 2”

4. R-Value: R-10

PART 3. EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.02 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 36" below exterior grade line.

2. Areas without below-grade spaces: place insulation 36" along the inside face of the exterior foundation wall.

3. Where shown on drawings, place insulation full height from bottom of foundation wall to grade on outside of foundation wall.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 36" in from exterior walls.

2. Areas without below-grade spaces: place insulation within 36" of foundation wall under concrete slab on grade.

END OF SECTION 07210

SECTION 07510 - BUILT-UP BITUMINOUS ROOFING

PART 1. GENERAL

1.01 SUMMARY

A. Section includes built-up asphalt roofing.

1.02 DEFINITION

A. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25° F measured at the mop cart or mechanical spreader immediately before application.

1.03 PERFORMANCE REQUIREMENTS

A. Roofing System Design: Provide built-up roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.

1. Corner Uplift Pressure: 65 lbf/sq. ft.

2. Perimeter Uplift Pressure: 45 lbf/sq. ft.

3. Field-of-Roof Uplift Pressure: 25 lbf/sq. ft.

B. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

C. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For cap sheet and flashing sheet, of color specified.

1.05 INFORMATIONAL SUBMITTALS

A. Research/evaluation reports.

B. Sample warranties.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

B. Source Limitations: Obtain components for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.

C. Pre-installation Roofing Conference: Conduct conference at Project site.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 BUILT-UP ROOFING MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Barrett Company.

2. CertainTeed Corp.

3. Ecology Commercial and Industrial Roofing Systems.

4. Fields Company, LLC.

5. Firestone Building Products.

6. GAF Materials Corporation.

7. Hickman, W. P. Systems, Inc.

8. Johns Manville.

9. Malarkey Roofing Company.

10. TAMKO Building Products, Inc.

11. Tremco, Incorporated.

12. U.S. Intec, Inc.; Division of BMCA.

2.02 BASE-SHEET MATERIALS

A. Base Sheet: ASTM D 4601, Type II, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.

1. Weight: 25 lb/100 sq. ft. minimum.

2. Basis of Design: Johns Manville GlasBase Plus.

2.03 ROOFING MEMBRANE PLIES

A. Ply Sheet: ASTM D 2178, Type VI, asphalt-impregnated, glass-fiber felt.

1. Basis of Design: Johns Manville GlasPly Premier.

B. Cap Sheet: ASTM D 3909, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

1. Basis of Design: Johns Manville GlasKap CR.

2.04 BASE FLASHING SHEET MATERIALS

A. Granule-Surfaced Flashing Sheet: ASTM D 6221, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, APP-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:

1. Granule Color: White

2. Basis of Design: Johns Manville DynaFlex CR

2.05 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D 41.

B. Roofing Asphalt: ASTM D 312, Type II or III as recommended by built-up roofing manufacturer for application.

2.06 AUXILIARY BUILT-UP ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing manufacturer for intended use and compatible with built-up roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

a) Plastic Foam Adhesives: 50 g/L.

b) Gypsum Board and Panel Adhesives: 50 g/L.

c) Multipurpose Construction Adhesives: 70 g/L.

d) Fiberglass Adhesives: 80 g/L.

e) Contact Adhesives: 80 g/L.

f) Other Adhesives: 250 g/L.

g) Nonmembrane Roof Sealants: 300 g/L.

h) Sealant Primers for Nonporous Substrates: 250 g/L.

i) Sealant Primers for Porous Substrates: 775 g/L.

B. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.

C. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.

2.07 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces. The total thickness shall have a minimum thermal resistance (R-value) of 30.

1. Basis of Design: Johns Manville ValueTherm 25PSI

B. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.08 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing manufacturer.

B. Cold-Applied Insulation Adhesive: Insulation manufacturer's recommended asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

C. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

D. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, ½” thick.

2.09 WALKWAYS

A. Walkway Pads: Polymer-modified, reconstituted solid-rubber, surface-textured, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to roofing manufacturer, 3/8 inch thick, minimum.

1. Pad Size: 24” x 24”.

PART 3. EXECUTION

3.01 INSULATION INSTALLATION

A. Comply with built-up roofing manufacturer’s written instructions for installing roof insulation.

B. Insulation Cant Strips: Install and secure preformed 45° insulation cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45°.

C. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2” or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6”) in each direction.

1. Where installing composite and noncomposite board insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

D. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

E. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.

2. Set each subsequent layer of insulation in cold-applied insulation adhesive, firmly pressing and maintaining insulation in place.

F. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.

1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

2. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.

3.02 BUILT-UP ROOFING INSTALLATION

G. Coordinate installation of roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

H. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.

I. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:

1. Adhere to substrate in a solid mopping of hot roofing asphalt.

J. Install two ply sheets starting at low point of roofing. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants.

1. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.

K. Cap Sheet: Install lapped granulated cap sheet starting at low point of roofing. Offset laps from laps of preceding ply sheets and align cap sheet without stretching. Lap in direction to shed water. Extend cap sheet over and terminate beyond cants.

1. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by built-up roofing manufacturer.

3.03 FLASHING AND STRIPPING INSTALLATION

A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer’s written instructions.

B. Extend base flashing up walls or parapets a minimum of 8” above built-up roofing and 4” onto field of built-up roofing.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

D. Install stripping, according to roofing manufacturer’s written instructions, where metal flanges and edgings are set on built-up roofing.

E. Roof Drains: Set 30” x 30” metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 4” beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.

3.04 WALKWAY INSTALLATION

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, according to walkway pad manufacturer’s written instructions.

1. Set walkway pads in additional pour coat of hot roofing asphalt after sweeping away loose aggregate surfacing.

END OF SECTION 07510

SECTION 07720 - ROOF ACCESSORIES

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Equipment supports.
3. Roof Hatches.
4. Automatic Roof Smoke Vents.
5. Safety Railing System.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory indicated.

B. Shop Drawings: For roof accessories.

C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items.

B. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.05 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer’s standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 10 years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.

1. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 coated.

1. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight

C. Aluminum Extrusions and Tubes: ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.

D. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.02 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-½" thick.

C. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide non-removable fastener heads to exterior exposed fasteners.

D. Sealants: As recommended by roof accessory manufacturer for installation indicated.

2.03 PERSONNEL ROOF ACCESS HATCH

A. Roof Access Hatches: Metal roof-hatch units with lids and insulated double walled curbs, welded or mechanically fastened and sealed corner joints,

continuous lid-to-curb counterflashing and weathertight perimeter gasketing and integrally formed deck-mounting flange at perimeter bottom.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Babcock-Davis BRHPG Personnel Series Roof Hatch or comparable product by one of the following:

   a) AES Industries, Inc.

   b) Bristolite Skylights.

   c) Custom Solution Roof and Metal Products.

   d) Dur-Red Products.

   e) Hi Pro International, Inc.

   f) J. L. Industries, Inc.

   g) Metallic Products Corp.

   h) Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.

   i) Naturalite Skylight Systems; Vistawall Group (The).

   j) Nystrom.

   k) O'Keeffe's Inc.

   l) Pate Company (The).

   m) Precision Ladders, LLC.

B. Type and Size: Single-leaf lid, 36” x 36”.

C. Loads: Minimum 40-lbf/sq. ft external live load and 20-lbf/sq. ft internal uplift load.

D. Hatch Material: Zinc-coated (galvanized steel sheet, 0.079” 14-gauge thick.

1. Finish: Baked enamel or powder coat.

2. Color: As selected by Architect from manufacturer’s full range .

E. Construction:

1. Insulation: Cellulosic-fiber or Glass-fiber board.

2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer’s standard metal liner of same material and finish as outer metal lid.

3. Curb Liner: Manufacturer’s standard, of same material and finish as metal curb.

4. Fabricate curbs to minimum height of 18” unless otherwise indicated.

5. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. Hardware: Galvanized-steel spring latch with turn handles inside and outside, butt- or pintle-type hinge system, and padlock hasps inside.

1. Provide two-point latch on lids larger than 84”.

G. Safety Railing System: Provide roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

2.04 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturer: Subject to compliance with requirements, provide a product from one of the following:

a) AES Industries, Inc.

b) Curbs Plus, Inc.

c) Custom Solution Roof and Metal Products.

d) Greenheck Fan Corporation.

e) LM Curbs.

f) Metallic Products Corp.

g) Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.

h) Pate Company (The).

i) Roof Products, Inc.

j) Safe Air of Illinois.

k) Thybar Corporation.

l) Vent Products Co., Inc.

B. Material: Zinc-coated (galvanized) 0.052” thick.

1. Finish: Mill phosphatized

C. Construction:

1. Insulation: Factory insulated with 1-½” cellulosic or glass-fiber board insulation.

2. Liner: Same material as curb, of manufacturer’s standard thickness and finish.

3. Factory-installed wood nailer at top of curb, continuous around curb perimeter.

4. Fabricate curbs to minimum height of 12” unless otherwise indicated.

5. Where roof slopes, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.

2.05 AUTOMATIC ROOF SMOKE VENTS

A. Hatch-Type Automatic Roof Smoke Vents: Manufacturer’s standard, with double-walled insulated curbs, welded or mechanically fastened and sealed corner joints, integral condensation gutter, and cap flashing. Fabricate with insulated double-walled lid and continuous weathertight perimeter lid gaskets, and equip with automatic self-lifting mechanisms and UL-listed fusible links rated at 165° F smoke-detection system.

1. Basis-of-Design Product: Subject to compliance with requirements, provide pre-assembled Babcock-Davis BSVLB 48” x 48” D2NR LightMAX Double Door Automatic Roof Smoke Vent or comparable product by one of the following:

a) Bilco Company (The).

b) Bristolite Skylights.

c) Dur-Red Products.

d) J. L. Industries, Inc.

e) Naturalite Skylight Systems; Vistawall Group (The).

f) Nystrom.

2. Type and Size: Double-leaf lid, 48” x 48”.

3. Loads: Minimum 40-lbf/sq. ft. external live load and 30-lbf/sq. ft. internal uplift load.

   a) When release is actuated, lid shall open against 10-lbf/sq. ft. snow or wind load and lock in position.

   b) Hatch-Lid Glazing: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.

4. Heat and Smoke Vent Standard: Provide units that have been tested and listed to comply with UL 793.

5. Curb, Framing, and Lid Material: Zinc-coated (galvanized) steel sheet, 0.079” thick.

   a) Finish: Two-coat fluoropolymer.

   b) Color: As selected by Architect from manufacturer's full range

6. Construction:

   a) Insulation: Polyisocyanurate board.

   b) Glazed, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.

   c) Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.

   d) Fabricate curbs to minimum height of 12” unless otherwise indicated.

   e) Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

7. Hatch-Lid Glazing: Double glazing of thickness capable of resisting indicated loads; white, translucent structured polycarbonate.

8. Hardware: Manufacturer’s standard, corrosion resistant or hot-dip galvanized; with hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.

B. Safety Railing System: Provide smoke vent manufacturer’s standard system including rails, clamps, fasteners, and accessories required for a complete

installation; attached to smoke vent and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

PART 3. EXECUTION

3.01 INSTALLATION

A. General: Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.

3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.

4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

C. Seal joints with sealant as required by roof accessory manufacturer.

3.02 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 “Exterior Painting” and Section 099123 “Interior Painting.”

C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07720

SECTION 07841 - THROUGH-PENETRATION FIRE STOP SYSTEM

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.

2. Penetrations in horizontal assemblies.

3. Penetrations in smoke barriers.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: For each penetration fire-stopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration fire-stopping condition, submit illustration, with modifications marked, approved by penetration fire-stopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 INFORMATIONAL SUBMITTALS

A. Installer Certificates: From Installer indicating penetration fire-stopping has been installed in compliance with requirements and manufacturer's written recommendations.

B. Product test reports.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Fire-Test-Response Characteristics: Penetration fire-stopping shall comply with the following requirements:

1. Penetration fire-stopping tests are performed by UL.

C. Pre-installation Conference: Conduct conference at Project site.

D. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

1.05 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's project coordinator at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's project coordinator or building inspector, if required by authorities having jurisdiction.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the penetration fire-stopping systems indicated for each application in the Through-Penetration Firestop System Schedule at the end of Part 3 that are produced by one of the following manufacturers:

1. Grace, W. R. & Co. - Conn.

2. Hilti, Inc.

3. Nelson Firestop Products.

4. Specified Technologies Inc.

5. 3M; Fire Protection Products Division.

2.02 FIRE-STOPPING, GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-

penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 “Performance Requirements” Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

a) Slag-/rock-wool-fiber insulation.

b) Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.

c) Fire-rated form board.

d) Fillers for sealants.

2. Temporary forming materials.

3. Substrate primers.

4. Collars.

5. Steel sleeves.

2.03 FILL MATERIALS

A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as “fill,” “void,” or “cavity” materials.

B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

F. Intumescent Putties: Non-hardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

H. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

I. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.

J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and other surfaces requiring a non-slumping, gunnable sealant, unless indicated firestop system limits use to non-sag grade for both opening conditions.

2.04 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

2.05 PENETRATION FIRE-STOPPING

A. Provide penetration fire-stopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration fire-stopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01” wg.

1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.

2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration fire-stopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30” wg (74.7 Pa) at both ambient and elevated temperatures.

E. Exposed Penetration Fire-stopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

PART 3. EXECUTION

3.01 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Install penetration fire-stopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-stopping.

D. Install fill materials for fire-stopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.02 IDENTIFICATION

A. Identify penetration fire-stopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6” of fire-stopping edge so labels will be visible to anyone seeking to remove penetrating items or fire-stopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Fire-stopping - Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor’s name, address, and phone number.

3. Designation of applicable testing and inspecting agency.

4. Date of installation.

5. Manufacturer’s name.

6. Installer’s name.

3.03 FIELD QUALITY CONTROL

A. The firestop products manufacturer’s representative shall visit the site a minimum of two times during installation of firestop systems to insure that systems are being properly installed. The firestop manufacturer’s representative shall provide a brief report to the Contractor indicating that materials were being properly installed and/or noting any deficiencies in the installation or use of the firestop systems. The Contractor shall forward one copy of each firestop manufacturer’s report to the Project Coordinator and Architect.

B. Where deficiencies are found or penetration fire-stopping is damaged or removed because of testing, repair or replace penetration fire-stopping to comply with requirements.

C. Proceed with enclosing penetration fire-stopping with other construction only after inspection reports are issued and installations comply with requirements.

3.04 PENETRATION FIRE-STOPPING SCHEDULE

3.05 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestop Systems with No Penetrating Items:

1. Framed Walls-UL-Classified Systems: W-L-0001-0999.

2. Type of Fill Materials: One or more of the following:

a) Latex sealant.

b) Silicone sealant.

c) Intumescent putty.

d) Mortar.

C. Firestop Systems for Metallic Pipes, Conduit, or Tubing:

1. Framed Walls-UL-Classified Systems: W-L-1001-1999.

2. Type of Fill Materials: One or more of the following:

a) Latex sealant.

b) Silicone sealant.

c) Intumescent putty.

d) Mortar

D. Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing

1. Framed Walls-UL-Classified Systems: W-L-2001-2999.

2. Type of Fill Materials: One or more of the following:

a) Latex sealant.

b) Silicone sealant.

c) Intumescent putty.

d) Intumescent wrap strips.

e) Firestop device.

E. Firestop Systems for Electrical Cables

1. Framed Walls-UL-Classified Systems: W-L-3001-3999.

2. Type of Fill Materials: One or more of the following:

a) Latex sealant.

b) Silicone sealant.

c) Intumescent putty.

d) Silicone foam.

e) Pillows/bags.

F. Firestop Systems for Insulated Pipes

1. Framed Walls-UL-Classified Systems: W-L-5001-5999.

2. Type of Fill Materials: One or more of the following:

a) Latex sealant.

b) Intumescent putty.

c) Silicone foam.

d) Intumescent wrap strips.

G. Firestop Systems for Miscellaneous Electrical Penetrants

1. Framed Walls-UL-Classified Systems: W-L-6001-6999.

2. Type of Fill Materials: One or more of the following:

a) Latex sealant.

b) Intumescent putty.

c) Mortar.

H. Firestop Systems for Miscellaneous Mechanical Penetrants

1. Framed Walls-UL-Classified Systems: W-L-7001-7999.

2. Type of Fill Materials: One or both of the following:

a) Latex sealant.

b) Mortar.

I. Firestop Systems for Groupings of Penetrants:

1. Framed Walls-UL-Classified Systems: W-L-3001-3999.

2. Type of Fill Materials: One or more of the following:

a) Latex sealant.

b) Mortar.

c) Intumescent wrap strips.

d) Firestop device.

e) Intumescent composite sheet.

END OF SECTION 07841

SECTION 07842 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1. GENERAL

1.01 SUMMARY

A. This Section includes fire-resistive joint systems for the following:

1. Head-of-wall joints.

2. Wall-to-wall joints.

B. Related Sections include the following:

1. Division 7 Section “Through-Penetration Firestop Systems” for systems installed in openings in walls and floors with and without penetrating items.

2. Division 7 Section “Joint Sealants” for non-fire-resistive joint sealants.

1.02 PERFORMANCE REQUIREMENTS

A. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.

B. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, with movement capabilities indicated as determined by UL 2079.

C. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition in which joints are installed; also show relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.

C. Product Certificates: For each type of fire-resistive joint system, signed by product manufacturer.

D. Qualification Data: For Installer.

E. At the completion of fire-resistive joint systems installation provide written certification by the fire-resistive joint systems product representative stating that the representative has inspected all locations where fire-resistive joint systems are installed or are required to be installed and the materials, products and systems are installed in accordance with the manufacturer's recommendations and U.L. requirements for that system.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."

B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

C. Source Limitations: Obtain fire-resistive joint systems, for each kind of joint and construction condition indicated, through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

1. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL.

2. Fire-resistive joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:

a) Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.

b) Fire-resistive joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.

3. At the completion of fire-resistive joint systems installation provide written certification by the fire-resistive joint systems product representative stating that the representative has inspected all locations where fire-resistive joint systems are installed or are required to be installed and the materials, products and systems are installed in

accordance with the manufacturer's recommendations and U.L. requirements for that system

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate fire-resistive joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

1.07 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's project coordinator at least seven days in advance of fire-resistive joint system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until Owner's project coordinator and building inspector of authorities having jurisdiction have examined each installation.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the fire-resistive joint systems indicated for each application in the Fire-Resistive Joint System Article

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

a) Grace, W. R. & Co. - Conn.

b) Hilti, Inc.

c) Nelson Firestop Products.

d) Specified Technologies Inc.

e) 3M; Fire Protection Products Division

2.02 FIRE-RESISTIVE JOINT SYSTEMS

A. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.

B. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 “Performance Requirements” Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.

2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer’s recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials. Remove tape as soon as possible without disturbing fire-resistive joint system’s seal with substrates or damaging adjoining surfaces.

3.03 INSTALLATION

A. General: Install fire-resistive joint systems to comply with Part 1 “Performance Requirements” Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.

B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.

2. Apply fill materials so they contact and adhere to substrates formed by joints.

3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD QUALITY CONTROL

A. The fire-resistive joint systems products manufacturer's representative shall visit the site a minimum of three times during installation of fire-resistive joint systems to insure that systems are being properly installed. The fire-resistive joint systems manufacturer's representative shall provide a brief report to the Contractor indicating that materials were being properly installed and/or noting any deficiencies in the installation or use of the firestop systems. The Contractor shall forward one copy of each firestop manufacturer's report to the Project Coordinator and Architect.

B. Where deficiencies are found, repair or replace fire-resistive joint systems so they comply with requirements.

C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. At the completion of all fire-resistive joint systems installation, the fire-resistive joint systems manufacturer's representative shall inspect the site and provide written certification stating that all required locations have been fire-stopped and the materials, products and systems are installed in accordance with the manufacturer's recommendations and U.L. requirements for the system.

3.05 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.06 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

A. Designation System for Joints in or between Fire-Resistance-Rated Constructions: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHBN.

B. Designation System for Joints at the Intersection of Fire-Resistance-Rated Floor or Floor/Ceiling Assembly and an Exterior Curtain-Wall Assembly: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHDG:

C. Head-of-Wall Fire-Resistive Joint Systems:

1. UL-Classified Systems: HW-D-0001-0999.

2. Assembly Rating: Maintain original fire-resistance rating of assembly in which joint system is installed.

3. Joint Width: 1-½".

4. Movement Capabilities: Class I.

D. Wall-to-Wall Fire-Resistive Joint Systems:

1. UL-Classified Systems: WW-D-0001-0999.

2. Assembly Rating: Maintain original fire-resistance rating of assembly in which joint system is installed.

a) Joint Width: 1-½".

b) Movement Capabilities: Class I.

END OF SECTION 07842

SECTION 07901 - JOINT SEALANTS

PART 1. GENERAL

1.01 SUMMARY

A. This Section includes joint sealants for the applications indicated in the Joint Sealant Schedule at the end of Part 3, including those specified by reference to this Section.

1.02 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.03 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer’s color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi component materials.

B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40° F.

2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are not in compliance with those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

PART 2. PRODUCTS

2.01 PRODUCTS AND MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each type in the sealant schedules at the end of Part 3.

2.02 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by the A/E from manufacturer's full range for this characteristic.

2.03 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.

B. Additional Movement Capability: Where additional movement capability is specified in the Elastomeric Joint-Sealant Schedule, provide products with

the capability, when tested for adhesion and cohesion under maximum cyclic movement per 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 of ASTM C 920 for uses indicated.

C. Stain-Test-Response Characteristics: Where elastomeric sealants are specified in the Elastomeric Joint-Sealant Schedule to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

2.04 LATEX JOINT SEALANTS

A. Latex Joint-Sealant Standard: Comply with ASTM C834 for each product of this description indicated in the Latex Joint Sealant Schedule at the end of Part 3.

2.05 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Expanded Polyethylene Joint Filler (EPJF): Extruded closed cell polyethylene foam. ASTM D1621, not less than 4 psi for 25 percent compression deflection. ASTM D1623, tensile strength not less than 36 psi. ASTM C509, water absorption not more than 0.1 percent by volume. Non-gassing. Resistant to petroleum oils and solvents. Provide one of the following, as acceptable to the sealant manufacturer.

1. NMC Inc. “Green-Rod”

2. Sonneborn “Sonofoam Closed Cell Backer Rod”

3. Williams Products Inc. “Everlastic Expand-O-Foam”

C. Expanded Neoprene Joint Filler (ENJF): ASTM D1056, Grade SCE41. Extruded closed cell neoprene foam.

1. D.S. Brown Co. “Closed Cell Neoprene”

2. Williams Products Inc. “Everlastic Neoprene Type NN1”

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.06 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:

a) Concrete.

b) Masonry.

c) Unglazed surfaces of ceramic tile.

3. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

a) Metal.

B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.

E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses provided for each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.04 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.06 ELASTOMERIC JOINT-SEALANT SCHEDULE

A. Silicone Sanitary Sealant: Provide products formulated with fungicide that are intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and temperature extremes, and that comply with the following:

1. Products: Provide one of the following:

a) 786 Mildew Resistant; Dow Corning.

b) Sanitary 1700; GE Silicones.

c) 898 Silicone Sanitary Sealant; Pecora Corporation.

d) Tremsil 200; Tremco.

2. Type and Grade: S (single component) and NS (non-sag).

3. Class: 25.

4. Use Related to Exposure: NT (non-traffic).

5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.

    a) Use O Joint Substrates: Galvanized steel and ceramic tile.

6. Applications: At joints of plumbing fixtures and walls in toilet rooms.

B. Single-Component Neutral-Curing Silicone Sealant:

1. Products:

    a) Tremco; Spectrem 3.

    b) Dow Corning Corporation; 791.

    c) Dow Corning Corporation; 795

    d) GE Silicones; UltraPruf II SCS2900.

2. Type and Grade: S (single component) and NS (non-sag).

3. Class: 50.

4. Use Related to Exposure: NT (non-traffic).

5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

    a) Use O Joint Substrates: Aluminum coated with a high-performance coating and galvanized steel.

6. Stain-Test-Response Characteristics: Non-staining to porous substrates per ASTM C 1248.

7. Applications: Wall joints; perimeter of door frames, windows, louvers and like penetrations.

C. 2-Part Polyurethane Modified Sealant: Provide products complying with the following:

1. Products: Provide one of the following:

    a) NP 2; Sonneborn Building Products Div., ChemRex Inc.

    b) Sikaflex-2cNS; Sika Corporation.

c) Dymeric, Tremco.

2. Type and Grade: M (multi component) and NS (non-sag).

3. Class: 25.

4. Uses Related to Exposure: T (traffic) and NT (non-traffic).

5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

a) Use O Joint Substrates: Aluminum coated with a high-performance coating, galvanized steel, masonry, ceramic tile, and wood.

6. Applications: Joints in horizontal surfaces.

D. 1-Part Polyurethane Sealant: Provide products complying with the following:

1. Products: Provide one of the following:

a) Sikaflex - 1a; Sika Corporation.

b) NP 1; Sonneborn Building Products Div.; ChemRex Inc.

c) Vulkem 116: Tremco.

2. Type and Grade: S (single component) and NS (non-sag).

3. Class: 25.

4. Uses Related to Exposure: T (traffic) and NT (non-traffic).

5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

a) Use O Joint Substrates: color anodic aluminum, galvanized steel, brick, ceramic tile, and wood.

6. Applications: Under exterior door thresholds.

3.07 LATEX JOINT-SEALANT SCHEDULE

A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF; One part, non-sag, mildew-resistant, sealant formulated to be paintable and recommended for exposed applications on interior involving joint movement of not more than plus or minus 5 percent.

1. Provide one of the following:

a) Bostik Findley; Chem-Calk 600.

b) Pecora Corporation; AC-20+

c) Sonneborn, Division of ChemRex Inc.; Sonolac.

d) Tremco; Tremflex 834

2. Applications: Interior finish joints, except air seal joints at exterior walls.

3.08 ACOUSTICAL JOINT-SEALANT SCHEDULE

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834 and the following:

1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2. Products: Provide one of the following:

a) Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.

b) United States Gypsum Co.; SHEETROCK Acoustical Sealant.

B. Applications: At perimeter trim of acoustical ceilings and interior partitions with sound insulation.

END OF SECTION 07901

SECTION 08100 - HOLLOW METAL DOORS AND FRAMES

PART 1. GENERAL

1.01 SUMMARY

A. Section includes the following:

1. Hollow-metal steel doors.
2. Hollow-metal steel door frames.
3. Hollow-metal steel window frames.

1.02 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required.

E. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain custom steel doors, frames and windows through one source from a single manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver doors, frames and windows palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs.

C. Store doors, frames and windows under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4" high, wood blocking. Avoid using non-vented plastic or canvas shelter that could create a humidity chamber.

1. If wrappers on doors become wet, remove cartons immediately. Provide minimum ¼" space between each stacked door to permit air circulation.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Apex Industries, Inc.

2. Ceco Door Products; an Assa Abloy Group company.

3. Curries Company; an Assa Abloy Group company.

4. LaForce, Inc.

5. Steelcraft; an Ingersoll-Rand company.

2.02 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.03 INTERIOR DOORS AND FRAMES

A. Heavy-Duty Doors and Frames: ANSI/SDI A250.8/SDI-100, Level 2

1. Physical Performance: Level B according to SDI A250.4.

2. Doors:

a) Type: As indicated in the Door and Frame Schedule.

b) Thickness: 1-¾".

c) Face: Uncoated, unless Metallic-coated (Galvanized) is indicated on door schedule, cold-rolled steel sheet, minimum thickness of 0.060" (16 Ga.).

d) Edge Construction: Model 2, Seamless.

e) Core: Vertical steel stiffener extending full door height at max. 6" on center.

3. Frames:

a) Materials: Uncoated, unless Metallic-coated (Galvanized) is indicated on door schedule, steel sheet, minimum thickness of 0.075" (14 Ga.).

b) Construction: Face welded.

4. Exposed Finish: Prime.

2.04 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8/SDI-100, Level 3.

1. Physical Performance: Level A according to SDI A250.4.

2. Doors:

a) Type: As indicated in the Door and Frame Schedule.

b) Thickness: 1-¾" (44.5 mm).

c) Face: Metallic-coated steel sheet, minimum thickness of 0.060" (16 Ga.), with minimum G60 coating in accordance with ASTM A-525, and mill phosphatized to permit paint adhesion

d) Edge Construction: Model 2, Seamless.

e) Core: Manufacturer's standard insulation material between vertical steel stiffeners extending full door height at max. 6" on center.

3. Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than R-7 when tested according to ASTM C 1363.

4. Frames:

a) Materials: Metallic-coated steel sheet, minimum thickness of 0.075" (14 Ga.), with minimum G60 coating in accordance with ASTM A-525.

b) Construction: Face welded

5. Exposed Finish: Prime

2.05 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042" thick, with corrugated or perforated straps not less than 2" wide by 10" long; or wire anchors not less than 0.177" thick.

2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042" thick.

3. Post-installed Expansion Type for In-Place Concrete, Masonry or Steel Frame installation: Minimum 3/8" diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042" and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2" height adjustment. Terminate bottom of frames at finish floor surface.

2.06 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: From corrosion-resistant materials.

G. Grout: ASTM C 476, except with a maximum slump of 4”, as measured according to ASTM C 143/C 143M.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing).

I. Glazing: Section 088000 “Glazing.”

J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat.

2.07 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer’s plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration. Provide top and bottom channels to close top and bottom edges of exterior doors with channels of same material thickness as face sheets, welded so webs of channels are flush with door edges.

2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelight Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

5. Jamb Anchors: Provide number and spacing of anchors as follows:

a) Masonry Type: Locate anchors not more than 16” from top and bottom of frame. Space anchors not more than 32” o.c., to match coursing, and as follows:

1) Two anchors per jamb up to 60” high.

2) Three anchors per jamb from 60 to 90” high.

3) Four anchors per jamb from 90 to 120” high.

4) Four anchors per jamb plus one additional anchor per jamb for each 24” or fraction thereof above 120” high.

b) Stud-Wall Type: Locate anchors not more than 18” from top and bottom of frame. Space anchors not more than 32” o.c. and as follows:

1) Three anchors per jamb up to 60” high.

2) Four anchors per jamb from 60 to 90” high.

3) Five anchors per jamb from 90 to 96” high.

4) Five anchors per jamb plus one additional anchor per jamb for each 24” or fraction thereof above 96” high.

c) Post-installed Expansion Type: Locate anchors not more than 6”from top and bottom of frame. Space anchors not more than 26” o.c.

6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers.

a) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

b) Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

E. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.

2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.

3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

4. Provide loose stops and moldings on inside of hollow-metal work.

5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.08 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer’s standard primer.

1. Shop Primer: SDI A250.10.

2.09 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016” thick.

PART 3. EXECUTION

3.01 INSTALLATION

A. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a) At fire-rated openings, install frames according to NFPA 80.

b) Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

c) Install frames with removable stops located on secure side of opening.

d) Install door silencers in frames before grouting.

e) Remove temporary braces necessary for installation only after frames have been properly set and secured.

f) Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

g) Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

a) Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly fill jambs with grout.

4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Concrete Walls: Solidly fill space between frames and concrete with grout.

6. In-Place Concrete or Masonry Construction or Steel framed opening: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a) Squareness: Plus or minus 1/16” measured at door rabbet on a line 90° from jamb perpendicular to frame head.

b) Alignment: Plus or minus 1/16”, measured at jambs on a horizontal line parallel to plane of wall.

c) Twist: Plus or minus 1/16”, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

d) Plumbness: Plus or minus 1/16”, measured at jambs at floor.

B. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a) Between Door and Frame Jambs and Head: 1/8” plus or minus 1/32”.

b) Between Edges of Pairs of Doors: 1/8” to ¼” plus or minus 1/32”.

c) At Bottom of Door: 5/8” plus or minus 1/32”.

d) Between Door Face and Stop: 1/16” to 1/8” plus or minus 1/32”.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

C. Glazing: Comply with installation requirements in Section 088000 “Glazing” and with hollow-metal manufacturer’s written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9” o.c. and not more than 2” o.c. from each corner.

3.02 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08100

SECTION 08410 - ALUMINUM ENTRANCES AND STOREFRONTS

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior manual-swing entrance door units

1.02 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.

1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples: For each exposed finish required.

D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.

1.04 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.07 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

2. Failure also includes the following:

a) Thermal stresses transferring to building structure.

b) Glass breakage.

c) Noise or vibration created by wind and thermal and structural movements.

d) Loosening or weakening of fasteners, attachments, and other components.

e) Failure of operating units.

2.02 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer series 500 doors or comparable product by one of the following:

1. Arcadia, Inc.
2. Arch Aluminum & Glass Co., Inc.
3. CMI Architectural.
4. Commercial Architectural Products, Inc.
5. EFCO Corporation.
6. Leed Himmel Industries, Inc.
7. Oldcastle Building Envelope.
8. Pittco Architectural Metals, Inc.
9. TRACO.
10. Tubelite.

2.03 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

1. Door Construction: 1-3/4" overall thickness, with minimum 0.125"-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods

   a) Thermal Construction for Exterior doors: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.

2. Door Design: Wide stile; 5" nominal width at sides and top and 6-1/2" at the bottom

3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

2.04 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08712 "Door Hardware."

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in “Entrance Door Hardware Sets” Article. Products are identified using entrance door hardware designations as follows:

1. Named Manufacturers’ Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers’ names are abbreviated in “Entrance Door Hardware Sets” Article.

2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

C. Butt Hinges: Specified in Section 08712.

D. Closers: Specified in Section 08712.

E. Exit Device and Lockset: Specified in Section 08712.

F. Silencers: BHMA A156.16, Grade 1.

G. Weather Stripping: Manufacturer’s standard replaceable components.

H. Weather Sweeps: Manufacturer’s standard exterior-door bottom sweep with concealed fasteners on mounting strip.

2.05 GLAZING

A. Glazing: Comply with Section 08800 “Glazing.”

B. Glazing Gaskets: Manufacturer’s standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.06 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.

2. Accurately fitted joints with ends coped or mitered.

3. Physical and thermal isolation of glazing from framing members.

4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.07 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611 AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3. EXECUTION

3.01 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.

2. Do not install damaged components.

3. Fit joints to produce hairline joints free of burrs and distortion.

4. Rigidly secure non-movement joints.

5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.

2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed as specified in Section 07901"Joint Sealants" to produce weather tight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 08800 "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weather tight enclosure and tight fit at weather stripping.

2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.02 FIELD QUALITY CONTROL

A. Aluminum-framed entrances will be considered defective if they do not pass inspections.

END OF SECTION 8410

SECTION 08620 – UNIT SKYLIGHTS

PART 1. GENERAL

1.01 SUMMARY

A. This Section includes factory-assembled unit skylights for installation in flat roof areas.

1. Type: Self flashing with integral curb and safety railing system.

2. Glazing: Acrylic

B. Related Sections include the following:

1. Division 6 Section “Rough Carpentry for wood framing and blocking at unit skylights.”

1.02 PERFORMANCE REQUIREMENTS

A. Structural Loads: Provide unit skylights, including glazing and anchorage, capable of withstanding the effects of the following design loads:

1. Snow Load: As indicated on structural drawings

2. Negative Pressure (Uplift) Load: As indicated on structural drawings and as required by local code requirements.

1.03 SUBMITTALS

A. Product Data: For unit skylights. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For unit skylights. Include plans, elevations, sections, details, and attachments to other Work.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in a representative section of each unit in manufacturer's standard size.

1.04 QUALITY ASSURANCE

A. Fire-Test Response Characteristics of Plastic Glazing: Provide plastic glazing sheets identical to those tested for fire-exposure behavior per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Self-Ignition Temperature: 650° F (343° C) or greater for plastic sheets in thickness indicated when tested per ASTM D 1929.

2. Smoke Production Characteristics: Comply with either requirement below:

   a) Smoke-Developed Index: 450 or less when tested per ASTM E 84 on plastic sheets in manner indicated for use.

   b) Smoke Density: 75 or less when tested per ASTM D 2843 on plastic sheets in thickness indicated for use.

3. Relative-Burning Characteristics: Tested per ASTM D 635.

   a) Acrylic Glazing: Class CC2, burning rate of 2.5” per minute or less for nominal thickness of 0.060” or thickness indicated for use.

   b) Polycarbonate Glazing: Class CC1, burning extent of 1” or less for nominal thickness of 0.060” or thickness indicated for use.

1.05 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Uncontrolled water leakage.

2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

3. Yellowing of acrylic glazing.

B. Warranty Period: Five years from Substantial Completion.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Skylights shall be Carlisle’s Drylight Skylight as manufactured by Carlisle Syntec, Greenville, IL.

B. Available Products: Subject to compliance with requirements, products from manufacturers that may be incorporated into the Work include, but are not limited to, the following:

1. American Skylites Inc.

2. Auburn Skylights, Major Industries, Inc.

3. Bristolite Skylights.

4. Kalwall Corporation.

5. Traco, Skytech Systems, Inc.

6. Wasco Products, Inc.

2.02 UNIT SKYLIGHTS

A. General: Factory-assembled units that include glazing, extruded-aluminum glazing retainers, gaskets, and inner frames and that are capable of withstanding design loads indicated.

B. Integral Curb: Self-flashing type.

1. Height: 9”.

2. Insulation: Manufacturer’s standard rigid type.

C. Unit Shape and Size: 48” by 48” inside curb

D. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, Category as standard with manufacturer, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).

1. Double-Glazing Profile: Dome, 25 percent rise

a) Outer Glazing Color: Colorless, transparent

b) Inner Glazing Color: Colorless, transparent

E. Glazing Gaskets: Manufacturer’s standard

F. Aluminum Components:

1. Sheets: ASTM B 209 (ASTM B 209M), alloy and temper to suit forming operations and finish requirements but with not less than the strength and durability of alclad alloy 3005-H25.

2. Extruded Shapes: ASTM B 221 (ASTM B 221M), alloy and temper to suit structural and finish requirements but with not less than the strength and durability of alloy 6063-T52.

3. Anodic Coating: Class I, color anodic coating complying with AAMA 611.

a) Color: As selected by Architect from manufacturer’s full range

G. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal as recommended by manufacturer. Finish exposed fasteners to match material being fastened.

H. Condensation Control: Fabricate unit skylights with integral internal gutters and nonclogging weeps to collect and drain condensation to the exterior.

I. Thermal Break: Fabricate unit skylights with thermal barrier separating interior metal framing from materials exposed to outside temperature.

J. Protective Screens: Manufacturer's standard to protect personnel from falls.

K. Safety Railing System: Provide skylight manufacturer's standard system including rails, clamps, fasteners, and accessories required for a complete installation; safety railing system shall comply with 29 CFR 1910.23 requirements and authorities having jurisdiction.

2.03 INSTALLATION MATERIALS

A. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic, nominally free of sulfur and containing no asbestos fibers, formulated for 15-mil (0.4-mm) dry film thickness per coating.

B. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

C. Elastomeric Sealant: STM C 920; Type S; Grade NS; Class 25; and Uses NT, G, A, and (as applicable to joint substrates indicated) O; recommended by unit skylight manufacturer and compatible with joint surfaces.

D. Roofing Cement: ASTM D 4586, asbestos free, designed for trowel application or other adhesive compatible with roofing system.

PART 3. EXECUTION

3.01 INSTALLATION

A. Coordinate unit skylight installation with installation of substrates, vapor retarders, roof insulation, roofing, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.

1. Unless otherwise indicated, install unit skylights according to construction details of NRCA's "The NRCA Roofing and Waterproofing Manual."

B. Where metal surfaces of units will contact incompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation recommended in writing by unit skylight manufacturer.

C. Anchor unit skylights securely to supporting substrates.

D. Set unit skylight flanges in thick bed of roofing cement to form a seal, unless otherwise indicated.

E. Where cap flashing is indicated, install to produce waterproof overlap with roofing or roof flashing. Seal with thick bead of mastic sealant except where overlap is indicated to be left open for ventilation.

3.02 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

1. Operating Units: Clean and lubricate joints and hardware. Adjust for proper operation.

END OF SECTION 08620

SECTION 08712 - DOOR HARDWARE

PART 1. GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical door hardware for the following:

a) Swinging doors.

2. Permanent lock cores to be installed by Owner.

1.02 RELATED WORK

A. The following sections prescribe items of work. Coordinated work prescribed by this section with work prescribed by the following sections:

1. Section “08100 Hollow Metal Doors and Frames.”

2. Section “08410 Aluminum Entrances, Storefronts and Windows.”

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed product and for each color and texture specified.

C. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a) Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

b) Content: Include the following information:

1) Identification number, location, hand, fire rating, size, and material of each door and frame.

2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.

3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.

5) Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

C. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

D. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

E. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

F. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

G. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC/ANSI A117.1

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.

2. Comply with the following maximum opening-force requirements:

a) Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.

b) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than ½" high.

4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3" from the latch, measured to the leading edge of the door.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

B. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

a) Exit Devices: Two years from date of Substantial Completion.

b) Manual Closers: 10 years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 HARDWARE MATERIALS AND FABRICATION

A. Produce hardware units of the basic metal indicated, using the manufacturer's standard metal alloy, composition, temper and hardness and with the finish specified. Use the manufacturer's standard production method for the class or quality of hardware units required.

B. Fasteners: Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.

1. Furnish screws for installation, with each hardware item. Provide tamperproof flat head screws except as otherwise indicated. Furnish tamperproof stainless steel screws for the attachment of all hardware items.

2. Furnish sufficient screws with each item to prevent delay in case of loss or damage in installing screws.

3. Provide concealed fasteners for hardware units which are exposed when the door is closed, except to the extent no standard manufactured units of the type specified are available which concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the exposed face is exposed except where it is not possible to adequately reinforce the work and use machine screws or concealed fasteners of another standard type.

4. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of hardware, base material or fastener.

5. Fiber, wood or iron expansion shields for installing hardware items are not acceptable. Use lead anchors or molley or toggle bolts, whichever is appropriate.

C. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of hardware for proper installation and operation of the door swing as shown.

2.02 HARDWARE FINISHES

A. General

1. Match the finish of every hardware unit at each door or opening, to the greatest extent possible. 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 hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish or the latch and lock set (or push-pulls units if no latch-lock sets) for color and texture.

2. A/E's representative will be the sole judge of whether hardware units match each other satisfactorily. Units will be judged when 2'-0" apart at 3'-0" distance.

3. Provide finishes that match those established by BHMA.

B. Standard Finish Designations: The designations used in schedules and elsewhere to indicate hardware finishes are those established by the Builders Hardware Manufacturers Association usually abbreviated BHMA, except where US number designations are used. Following is a list of BHMA finishes cross referenced to US numbers.

BHMA CODE	FINISH DESCRIPTION	NEAREST U.S. EQUIVALENT
600	Prime Coat Paint (steel base)	US P
626	Brushed Chrome (brass/bronze base)	US 26 D
628	Brushed Aluminum, Anodized	US 28
630	Brushed Stainless Steel	US 32 D
652	Brushed Chrome (steel base)	US 26 D
689	Finish Coat Paint (steel base aluminum color)	

Specific Hardware Material Requirements

C. While the hardware list is intended to cover all door and other movable parts of the building and establish a type and standard of quality, it shall be the specific duty and responsibility of the finish hardware supplier to examine the Drawings and Specification and furnish proper hardware for all openings whether listed or not. If there are any omissions in hardware listing in regard to regular doors, they shall be called to the attention of the owner prior to award of contract.

D. Items of hardware not definitely specified herein, excepting hardware excluded above, but necessary for completion of the work shall be provided. Such items shall be of type and quality suitable to the service required and comparable to the adjacent hardware. Where size and shape of members is such as to prevent the use of types specified, hardware shall be furnished of suitable types having as nearly as practicable the same operation and quality as the type specified. Sizes shall be adequate for the service required.

2.03 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled on Drawings to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products or products complying with BHMA designations referenced.

2.04 HINGES

A. Meet requirements of ANSI/ BHMA A156.1.

B. Finish: 630.

C. Meet requirements of ANSI A156.1

D. Include the following options:

1. Heavy duty ball bearing hinges.

2. Full mortise butt type.

3. Five (5) knuckle design.

4. Stainless steel non-rising pins.

5. Non-removable pins (NRP) on reverse bevel doors to be locked.

E. Sizes: Furnish quantity, size and gauge as recommended by the Manufacturer subject to the following minimum requirements:

1. Height of Hinges

a) For doors 36” wide or less 4-1/2” height.

b) For doors over 36” to 48” wide – 5” height.

c) For doors over 48” wide – 6” height.

2. Width of Hinges

a) For hinge height up to 5” high - 4 ½” width.

b) For hinge height of 5” high and over – 5” width.

3. Number of Hinges

a) Doors 60” high or less – 2.

b) Over 60” not over 90”– 3.

c) Over 90” not over 120” – 4.

d) 1 hinge for each 30” over 120”.

F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hager Companies.

2. IVES Hardware; an Ingersoll-Rand company.

3. McKinney Products Company; an ASSA ABLOY Group company.

4. Stanley Commercial Hardware; Div. of The Stanley Works.

2.05 MECHANICAL LOCKS AND LATCHES

A. Strikes: Provide manufacturer’s standard strike for each lock bolt or latch-bolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latch-bolts, as recommended by manufacturer.

2. Aluminum-Frame Strike Box: Manufacturer’s special strike box fabricated for aluminum framing.

B. Basis of Design: Stanley Best “9K Series,” with interchangeable 7-pin core, series 15D Lever style as manufactured by Sargent Division of Assa Abloy.

C. Lock Type: Heavy Duty cylindrical Locks ANSI/BHMA A156.2; Series 4000 Operational Grade 1; stamped steel case with steel or brass parts.

D. General Requirements:

1. Locks and trim must be of the same Manufacturer and must conform to requirements of ANSI 156.5.

2. Levers on doors to stairs, mechanical rooms and other hazardous areas must be knurled and comply with the requirements of ANSI A117.1.

3. Finish: 626.

E. Levers: Solid Cast Lever L section stainless steel, “contour angle return” style, fully ADA compliant.

F. Trim: 3-3/8” diameter rose.

G. Function: As indicated in hardware schedule and cross-referenced to ANSI No. as follows:

1. Office: F109.

2. Privacy: F76.

3. Entrance: F109.

4. Storage/Storeroom: F86.

5. Classroom: F84

H. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adams Rite Manufacturing Co.; an Assa Abloy Group company.

2. Corbin Russwin Architectural Hardware; an Assa Abloy Group company.

3. Schlage Commercial Lock Division; an Ingersoll-Rand company.

4.Yale Security Inc.; an Assa Abloy Group company.

2.06 PUSH/PULLS

A. Must be furnished on all doors not equipped with a lockset or latch-set.

B. Sizes:

1. Push plate: 6” x 16”.

2. Pull plate: 4” x 16” with 3/8” thick x 1-1/4” wide rectangular pull (8” CTC). Provide 2 ½” clearance at pulls.

3. Plates: 1/8” thick, engraved “push” and “pull”; back to back mounting and beveled 4 sides.

4. Attach with stainless steel tamperproof screws.

C. Finish: 630.

D. Available Manufacturers, subject to compliance with requirements above:

1. Hager Companies, St. Louis, MO 63104.

2. Rockwood Manufacturing Co., Rockwood, PA 15557.

3. Hiawatha Inc., Bloomington, MN 55435.

2.07 EXIT DEVICES

A. General: Provide rim type push-bar exit devices unless specified otherwise. Provide Fire rated exit devices on rated doors.

B. Meet requirements for BHMA A156.3, Grade 2.

C. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

D. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

1. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

E. Outside Trim: as called for in hardware set; material and finish to match locksets, unless otherwise indicated.

F. Dogging: Provide cylinder dogging where indicated on the drawings.

G. Finish: 630.

H. Available Manufacturers, subject to compliance with requirements above:

1. Corbin Russwin Architectural Hardware; an Assa Abloy Group company (CR).

2. Adams Rite Manufacturing Co. (ARM).

3. Yale Commercial Locks and Hardware; an Assa Abloy Group company (YAL).

4. Von Duprin; an Ingersoll-Rand Company (VD).

5. SARGENT Manufacturing Company; an Assa Abloy Group company (SGT).

2.08 DOOR CLOSERS

A. General:

1. Meet requirements for grade 1 closers in accordance with ANSI A 156.4.

2. All closers shall have delayed action, opening force and closing speed as required by ANSI A117.1.

3. Mounting Side: Install on inside of building for exterior doors and on inside of rooms unless noted otherwise.

4. When the term “closer” is used in hardware set without any qualification as to type, it shall be understood to mean door face mounted exposed type.

5. Provide all closers by the same manufacturer.

6. Provide closers with heavy duty arms, cast iron body and any plates, brackets, supports, adapters or other accessories as required for complete installation.

B. Basis of Design: LCN 4040 Series by LCN Closers of Princeton, IL.

C. Size of closer must be manufacturer’s recommendations consistent with warranty.

D. Construction:

1. Full rack and pinion type.

2. Metal covers.

3. Cast iron body.

4. Heat treating steel working parts.

5. All-weather fluids.

E. Provide integral stops and holders as called for on the drawings. Integral stops shall be of spring-cushioned kind. Do not provide holders on fire rated doors.

F. Design of closers must be modern type with metal cover.

G. Unless otherwise indicated, mount closers on side of door away from corridors and public areas. Mount closers on inside of exterior doors. Provide parallel-arm door closers as required.

H. Finish: 689.

I. Available Manufacturers, subject to compliance with requirements above:

1. Corbin/Russwin, Berlin, CT 06037.

2. LCN Closers, Princeton, IL 61356.

3. Norton Door Controls, Charlotte, NC 28229.

4. Sargent Manufacturing Co., New Haven, CT 06511.

2.09 DOOR PROTECTION PLATES

A. Meet requirements of ANSI A156.6

B. Category J100 door protection plates:

1. Beveled four edges.

2. Thickness: 0.050 inch stainless steel.

3. Finish: 630 (US 32D).

4. Type J102 kick plate, 10” high.

5. Type J103 mop plate, 4” high.

6. Half-height protection plate: 34” high.

7. For push side of door, 1½” less than door width.

8. For pull side of door, 1” less than door width.

C. Available Manufacturers, subject to compliance with requirements above:

1. Hager Companies, St. Louis, MO 63104.

2. Hiawatha Inc., Bloomington, MN 55435.

3. H.B. Ives Manufacturing Co., Wallingford, CT 06492.

4. Rockwood Manufacturing Co., Rockwood, PA 15557.

2.10 DOOR STOPS

A. General: Provide a stop for each door unless specifically indicated otherwise by a note, “no stops required”. Stops must conform to the following:

1. Overhead stops and holders must meet requirements for ANSI A156.8.

2. Finish: 630

3. Wall stops must meet requirement of ANSI A 156.16.

4. Where wall conditions permit and stop can contact with lever, use wall type bumper L02101.

5. Where a wall type bumper cannot be used, furnish overhead stop/holder ANSI type 156.8 CO2511 or CO2541 at fire-rated doors: Concealed, heavy duty, hold-open and stop, hold-open function on or off by control knob, adjustable tension on hold-open.

6. Finish: 630. All tamperproof stainless steel screws and attachments. Include fillers, brackets and all options required to coordinate with surface mounted closers. Holder set to 95º if conditions permit.

7. Available Manufacturers, subject to compliance with requirements above:

   a) Overhead Stop/Holders

      1) Glynn-Johnson, Indianapolis, IN 46219.

      2) Yale Security, Inc., Charlotte, NC 28229.

      3) Sargent Manufacturing Co., New Haven, CT 06511.

   b) Wall bumpers

      1) Glynn-Johnson, Indianapolis, IN 46219.

      2) Hager Companies, St. Louis, MO 63104.

      3) Hiawatha Inc., Bloomington, MN 55435.

2.11 WEATHERSTRIPPING AND DOOR SEALS

A. Weather-stripping must conform to the following:

1. Must be furnished on all exterior doors.

2. Stainless steel retainer with neoprene insert.

3. One of the following Products will be acceptable:

   a) Zero Weather-stripping Company - #328.

b) Pemko - # 319.

c) Reese - #403.

B. Exterior Threshold must conform to the following:

1. Must be furnished on all exterior doors.

2. Finish: Satin nickel anodized aluminum .

3. Provide slip resistant, non-skid surface.

4. Provide full thermal break at exterior doors.

5. One of the following Products will be acceptable:

a) Zero Weather-stripping Company - #626.

b) Pemko - # 253X3AFG

c) Reese - #S473A

C. Interior Thresholds must conform to the following:

1. Finish: Satin nickel anodized aluminum .

2. Provide slip resistant, non-skid surface.

3. Provide full with of door frame, cut to fit around door stop.

4. Provide beveled edges at max. slope of 2H:1V.

5. Products from the following Manufacturers are acceptable subject to compliance with requirements:

a) Zero Weather-stripping Company.

b) Pemko

c) Reese

D. Rain Drips must conform to the following:

1. Must be furnished on all exterior doors.

2. Anodized Aluminum rain drip mounted on outside of door above door.

a) Basis of Design: Reese – R201A.

3. Products from the following Manufacturers are acceptable subject to compliance with requirements:

a) Zero Weather-stripping Company

b) Pemko

E. Door Bottom Sweep must conform to the following:

1. Must be furnished on all exterior doors.

2. Stainless steel retainer with neoprene insert.

3. Basis of Design: Pemko - # 323A.

4. Products from the following Manufacturers are acceptable subject to compliance with requirements:

a) Zero Weather-stripping Company.

b) Reese.

F. Split Astragal must conform to the following:

1. Surface mounted split Astragal.

2. Complies with BHMA A156.21.

3. Finish: Anodized Aluminum.

4. Must not interfere with other door hardware.

5. Basis of Design: Pemko - # 303CS.

6. Products from the following Manufacturers are acceptable subject to compliance with requirements:

a) Zero Weather-stripping Company.

b) Reese.

G. Smoke Seal must conform to the following:

1. Must conform to UL 1784 for Air Leakage Test of Door Assemblies.

2. Finish: Anodized Aluminum.

3. Must not interfere with door closer and other door hardware.

4. Basis of Design: Pemko - # 2891P.

5. Products from the following Manufacturers are acceptable subject to compliance with requirements:

a) Zero Weather-stripping Company.

b) Reese.

2.12 MISCELLANEOUS HARDWARE

A. Astragals: BHMA A156.22.

B. Coordinators (Bar Coordinator) must conform to the following:

1. BHMA A156.3 type 21A.

2. Shall be UL listed for installation on fire rated door frames.

3. Shall be compatible with flush-bolts.

4. Provide filler bars as required to cover entire length of the stop.

5. Mounted to top stop – provide mounting brackets as required for other stop applied hardware.

6. Must not interfere with other door hardware.

7. Basis of Design: IVES COR-series.

C. Manual Flush Bolts must conform to the following:

1. BHMA A156.16 Grade 1 designed for mortising into door edge.

2. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

a) Mortise Flush Bolts: Minimum ¾” throw.

D. Dustproof Strikes: Provide dustproof strikes at all doors indicated to receive Flush Bolts: BHMA A156.16 Grade 1.

E. Products from the following Manufacturers are acceptable subject to compliance with requirements:

1. Adams Rite Manufacturing Co. (ARM).

2. Burns Manufacturing Incorporated (BM).

3. Don-Jo Mfg., Inc. (DJO).

4. Door Controls International (DCI).

5. Glynn-Johnson; an Ingersoll-Rand Company (GJ).

6. Hager Companies (HAG).

7. IVES Hardware; an Ingersoll-Rand Company (IVS).

8. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

9. Trimco (TBM).

F. Automatic (Self-latching) Flush Bolts must conform to the following:

1. BHMA A156.16 designed for mortising into door edge.

2. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

a) Mortise Flush Bolts: Minimum ¾" throw.

3. Dustproof Strikes: Provide dustproof strikes at all doors indicated to receive Flush Bolts: BHMA A156.16.

4. Provide stainless steel door protection plates where latches contact active leaf of door.

5. Products from the following Manufacturers are acceptable subject to compliance with requirements:

a) Adams Rite Manufacturing Co. (ARM).

b) Burns Manufacturing Incorporated (BM).

c) Don-Jo Mfg., Inc. (DJO).

d) Door Controls International (DCI).

e) Glynn-Johnson; an Ingersoll-Rand Company (GJ).

f) Hager Companies (HAG).

g) IVES Hardware; an Ingersoll-Rand Company (IVS).

h) Stanley Commercial Hardware; Div. of The Stanley Works (STH).

i) Trimco (TBM).

G. Door Silencers must conform to the following:

1. Three (3) for each single door

2. Two (2) for each pair of doors.

3. None required on doors with smoke seals or weather-stripping.

4. One of the following Manufacturers will be acceptable:

a) Glynn-Johnson, Indianapolis, IN 46219.

b) Hager Companies, St. Louis, MO 63104.

c) Hiawatha Inc. Bloomington, MN 55435.

H. Latch Protector must conform to the following:

1. Stainless steel.

2. Size: 1-1/2” x 10” – 0.105” thick for mortise type locks.

3. Through bolted, tamperproof on outside.

4. One of the following Manufacturers will be acceptable:

a) McKinney Hinge, an Assa Abloy Company.

b) Or approved equal.

2.13 LOCK CYLINDERS

A. Cylinders: BEST 7-pin small format interchangeable Core capable of master keying, construction keying and adaptable to existing keying system on site.

B. Construction Keying: Comply with the following:

1. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

a) Furnish only temporary construction cores for the construction period and remove these when directed by the owner.

b) Owner will furnish and install final cores and keys.

2.14 KEYING

A. All keying will be handled by owner.

2.15 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:

   a) Wood or Machine Screws: For the following:

      1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.

      2) Strike plates to frames.

      3) Closers to doors and frames.

   b) Steel Through Bolts: For the following unless door blocking is provided:

      1) Surface hinges to doors.

      2) Closers to doors and frames.

      3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, “Recommended Fasteners for Wood Doors.”

5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.16 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3. EXECUTION

3.01 INSTALLATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

B. Wood Doors: Comply with DHI WDHS.5 “Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors.”

C. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

2. Custom Steel Doors and Frames: HMMA 831.

3. Wood Doors: DHI WDHS.3, “Recommended Locations for Architectural Hardware for Wood Flush Doors.”

D. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

E. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30” (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

F. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.

2. Furnish permanent cores to Owner for installation.

G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 “Joint Sealants.”

H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

L. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.02 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

END OF SECTION 08712

SECTION 08810 - GLAZING

PART 1. GENERAL

1.01 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.

2. Doors.

3. Glazed curtain walls.

4. Glazed entrances.

5. Interior borrowed lites..

6. Exterior entrance canopy glazing.

1.02 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:

a) Specified Design Wind Loads: 90 mph

b) Specified Design Wind Loads: 30psf but not less than wind loads applicable to Project as required by ASCE 7 “Minimum Design Loads for Buildings and Other Structures”: Section 6.0 “Wind Loads.”

c) Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 30 feet above grade, according to ASCE 7, “Minimum Design Loads

for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.

1) Basic Wind Speed: 90 mph.

2) Importance Factor: I=1.0.

3) Exposure Category: C.

d) Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1" whichever is less.

1) For monolithic-glass lites heat treated to resist wind loads.

2) For insulating glass.

3) For laminated-glass lites.

e) Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 180° F material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick

2. For laminated-glass lites, properties are based on products of construction indicated.

3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.

4. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:

a) U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F

b) Solar Heat Gain Coefficient: NFRC 200.

c) Solar Optical Properties: NFRC 300.

1.03 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

1.04 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

C. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1.05 INFORMATIONAL SUBMITTALS

A. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

B. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association’s Certified Glass Installer Program.

B. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

C. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency.

2. Where glazing units, including Kind FT glass are specified in Part 2 articles for glazing lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

E. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Glazing Manual."

1.07 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through

glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: 5 years from date of Substantial Completion.

C. Manufacturer’s Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer’s written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with “Performance Requirements” Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with “Performance Requirements” Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer’s published test data, based on procedures indicated below:

1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL’s WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F

2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL’s WINDOW 5.2 computer program.

3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.02 GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.

B. Heat-Strengthened Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.

C. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

2.03 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.

2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.

3. Interlayer Color: Clear unless otherwise indicated.

2.04 INSULATING GLASS

A. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 “Insulating-Glass Units” Article.

1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 “Performance Requirements” Article.

2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.

3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.

4. Sealing System: Dual seal, with primary and secondary sealants as follows:

a) Manufacturer’s standard sealants.

5. Spacer Specifications: Manufacturer’s standard spacer material and construction.

2.05 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.

B. Film-Faced Ceramic Glazing: Clear, ceramic flat glass; 1/4” nominal thickness; faced on one surface with a clear glazing film; complying with testing requirements in 16 CFR 1201 for Category II materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a) Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite NT.

b) Safti First; SuperLite C/SP.

c) Schott North America, Inc.; Filmed Pyran Star.

d) Vetrotech Saint-Gobain; SGG Keralite FR-F.

2.06 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:

1. Neoprene complying with ASTM C 864.

2. EPDM complying with ASTM C 864.

3. Silicone complying with ASTM C 1115.

4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone, or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.07 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.08 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

B. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

E. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

F. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.09 MONOLITHIC-GLASS TYPES

A. Glass Type GL-1 (Glazing in doors and sidelights): Clear fully tempered float glass.

1. Thickness: 6.0 mm (1/4”).

2. Provide safety glazing labeling.

2.10 INSULATING-GLASS TYPES

A. Glass Type GL-2 (Glazing at exterior entrance canopy): 1-5/16” Insulating Glass

1. Overall Unit Thickness: 1-5/16”.

2. Minimum Thickness of Each Glass Ply: 6.0 mm (1/4”).

3. Top Lite: 6.0 mm Fully tempered and tinted float glass.

4. Top Lite Tint Color: Grey

5. Top Lite Ceramic Coating Color and Pattern: Match White Ceramic Frit Silk-screened Standard Dot Pattern (1/8” dots staggered on 1/4” centers, equal to 40% coverage) as manufactured by Trulite Glass & Aluminum Solutions.

6. Top Lite Coating Location: Second surface. (Note: The surfaces here are described as top looking down).

7. Interspace Content: 1/2” Air.

8. Bottom Lite: 9/16” Fully tempered laminated clear float glass.

a) Laminated Glass Top lite: 6.0 mm fully tempered clear float glass

b) Interspace Content: Polyvinyl Butyral.

c) Interlayer Thickness: 0.060” PVB.

d) Bottom Lite: 6.0 mm fully tempered clear float glass.

9. Safety glazing required.

B. Glass Type GL-3: Low-e-coated, tinted insulating glass (Grey)

1. Overall Unit Thickness: 1”.

2. Thickness of Each Glass Lite 6.0 mm (1/4”).

3. Outdoor Lite: fully tempered coated and tinted float glass.

4. Interspace Content: Air.

5. Indoor Lite: fully tempered clear float glass.

6. Basis of Design: Pilkington Eclipse Advantage (Solar Control Low-E) – Grey

7. Color: Grey

8. Low-E Coating: Pyrolytic or sputtered on second surface.

9. Visible Light Transmittance: 29 percent minimum.

10. Winter Nighttime U-Factor: 0.35 maximum.

11. Summer Daytime U-Factor: 0.35 maximum.

12. Solar Heat Gain Coefficient: 0.33 maximum.

2.11 FIRE-PROTECTION-RATED GLAZING TYPES

A. Glass Type GL-4: 45-minute fire-rated glazing; film-faced ceramic glazing.

1. Provide safety glazing labeling.

B. Glass Type GL-5: 90-minute fire-rated glazing; film-faced ceramic glazing.

1. Provide safety glazing labeling.

PART 3. EXECUTION

3.01 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50”.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.02 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. 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.

F. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.03 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weather tight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weather tight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.04 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.05 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION 08810

SECTION 08911 - ALUMINUM FRAMED CURTAIN WALL SYSTEM

PART 1. GENERAL

1.01 SUMMARY

A. Section includes glazed aluminum curtain walls.

1.02 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project Site.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.

1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples: For each exposed finish required.

D. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Aluminum curtain wall system shall withstand code required loads and additional loads indicated to support the exterior canopy.

1.04 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.

B. Product test reports.

C. Field quality-control reports.

D. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.07 WARRANTY

A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

2. Failure also includes the following:

a) Thermal stresses transferring to building structure.

b) Glass breakage.

c) Noise or vibration created by wind and thermal and structural movements.

d) Loosening or weakening of fasteners, attachments, and other components.

e) Failure of operating units.

B. Structural Loads:

1. Wind Loads: As required by IBC2009 and ASCE 7.

2. Canopy Loads: As indicated on drawings

C. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4", whichever is less.

2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8", whichever is smaller.

D. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 120° F ambient; 180° F, material surfaces.

2.02 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer 1600 Wall System 1 or comparable product by one of the following:

1. Arcadia, Inc.

2. Arch Aluminum & Glass Co., Inc.

3. Bruce Wall Systems Corporation.

4. CMI Architectural.

5. EFCO Corporation.

6. Pittco Architectural Metals, Inc.

7. Shuco USA LP.

8. Tingwall Inc.

9. TRACO.

10. United States Aluminum.

11. Unitized Systems LLC.

12. Waltek & Company Limited.

2.03 FRAMING

A. Framing Members: Manufacturer’s extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken

2. Glazing System: Retained mechanically with gaskets on four sides.

3. Glazing Plane: Front.

4. Finish: Clear anodic finish.

5. Fabrication Method: Either factory- or field-fabricated system.

B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

1. Include snap-on aluminum trim that conceals fasteners.

C. Brackets and Reinforcements: Manufacturer’s standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

D. Curtain wall system manufacturer to provide entrance door framing with flush door adapter to receive exterior aluminum storefront entrance door per specification Section 08410.

E. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

a) Sheet and Plate: ASTM B 209.

b) Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221

c) Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.

d) Structural Profiles: ASTM B 308/B 308M.

2. Steel Reinforcement: Manufacturer’s standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied

immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

a) Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.

b) Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.

c) Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.04 GLAZING

A. Glazing: Comply with Section 08800 “Glazing.”

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.05 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.

2. Accurately fitted joints with ends coped or mitered.

3. Physical and thermal isolation of glazing from framing members.

4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

5. Provisions for field replacement of glazing from exterior.

6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

7. Provisions for Entrance door framing with flush door adapter.

D. Fabricate components to resist water penetration as follows:

1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Factory-Assembled Frame Units:

1. Rigidly secure non-movement joints.

2. Prepare surfaces that are in contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.

3. Preparation includes, but is not limited to, cleaning and priming surfaces.

4. Seal joints watertight unless otherwise indicated.

5. Install glazing to comply with requirements in Section 08800 “Glazing.”

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.06 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3. EXECUTION

3.01 INSTALLATION

A. General:

1. Comply with manufacturer’s written instructions.

2. Do not install damaged components.

3. Fit joints to produce hairline joints free of burrs and distortion.

4. Rigidly secure non-movement joints.

5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

7. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.

2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

D. Install components plumb and true in alignment with established lines and grades.

E. Install glazing as specified in Section 08800 “Glazing.”

END OF SECTION 08911

SECTION 09260 - GYPSUM BOARD ASSEMBLIES

PART 1. GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Non-load-bearing steel framing members for gypsum board assemblies.
2. Gypsum board for gypsum board partitions and ceilings
3. Accessories for installation and trimming of gypsum board.
4. Gypsum board soffit assemblies.
5. Shaft-wall enclosures
6. Chase enclosures

1.02 DEFINITIONS

A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.03 SUBMITTALS

A. Product Data: Manufacturer's technical data for each type of product specified.

B. Accessories: Manufacturer’s technical data for each accessory type used.

1.04 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction

1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

C. Handle gypsum board to prevent damage to edges, ends and surfaces. Do not bend or damage metal corner beads and trim.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Ventilation: Ventilate building spaces, as required, for drying joint treatment materials. Avoid drafts during hot dry weather to prevent finishing materials from drying too rapidly.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Framing and Furring:
   a) Clark Steel Framing Systems.
   b) Consolidated Systems, Inc.
   c) Dietrich Industries, Inc.

2. Gypsum Board and Related Products:
   a) G-P Gypsum.
   b) National Gypsum Company.
   c) USG Corporation.

2.02 STEEL SUSPENDED SOFFIT FRAMING

A. Components, General: Comply with ASTM C 754 for conditions indicated

B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625 inch diameter wire, or double strand of 0.0475 inch diameter wire.

C. Hanger Attachments to Concrete: As follows:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching hanger wires and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by a qualified independent testing agency.
2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.

D. Hangers: As follows:

1. Wire Hangers: ASTM A641, Class 1 zinc coating, soft temper, 0.162 diameter.

E. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A653, G40, hot-dip galvanized zinc coating.

1. Steel Studs: ASTM C645.
   a) Minimum Base Metal Thickness: 0.0329 inches
   b) Depth: As indicated on drawings.
2. Hat-shaped, rigid furring channels: ASTM C645 - 7/8 inch deep
   a) Minimum Base Metal Thickness: 0.0329 inch.

2.03 STEEL PARTITION FRAMING

A. Components, General: As follows:

1. Comply with ASTM C754 for conditions indicated.
2. Steel Sheet Components: Complying with ASTM C645 requirements for metal and with ASTM A653/A, G60, hot-dip galvanized zinc coating.

B. Steel Studs and Runners: ASTM C645.

1. Minimum Base metal Thickness: 0.0329 inch, unless otherwise shown
2. Depth: As indicated on drawings.

C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base Metal Thickness: 0.0329 inch

D. Hat-Shaped, Rigid Furring Channels: ASTM C645.

1. Minimum Base Metal Thickness: 0.0329 inch.

2. Depth: 7/8 inch.

E. Furring Brackets: Serrated arm type, adjustable, fabricated from corrosion resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.

F. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.04 INTERIOR GYPSUM WALLBOARD

A. General: Complying with ASTM C 36 or ASTIM C 1396, as applicable to type of gypsum board indicated and whichever is more stringent.

B. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

C. Gypsum Wallboard: ASTM C 36.

D. Regular Type:

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

E. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board. – Use Water Resistant Glass-Mat Board in Washroom ceilings and soffits.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

F. Fire-Resistive Type: ASTM C36, having improved fire resistance over standard Type X.

1. Products: Subject to compliance with requirements, provide one of the following:
   a) American Gypsum Co.: FireBlock Type C
   b) National Gypsum Company: Gold Bond Fire-Shield G
   c) United States Gypsum Co.: SHEETROCK Brand Gypsum Panels, FIRECODE C Core.
   d) G-P Gypsum.
2. Thickness: 5/8 inch
3. Long Edges: Tapered.

G. Water Resistant Glass-Mat Board: With moisture and mold resistant core, glass mat facing on both side of panel, type x.

1. Mold Resistance: ASTM D 3273; no mold growth after four weeks exposure.
2. Thickness: As indicated on drawings.
3. Product: Georgia-Pacific DensGuard Tile Backer

H. Impact Resistant Gypsum Board: Moisture-resistant, noncombustible dense gypsum core with a strong layer of embedded mesh with abuse-resistant coated fiberglass mats.

1. Mold Resistance: ASTM D 3273;
2. Thickness: As indicated on drawings.
3. Product: Georgia-Pacific DensArmor Plus Impact-Resistant Interior Panel.

2.05 GYPSUM SHAFTWALL PANEL PRODUCTS

A. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.

1. Type X: Manufacturer's proprietary liner panels with moisture-resistant paper faces.
   a) Core: 1 inch thick.
   b) Long Edges: Double bevel.
2. Moisture-and Mold-Resistant Type X: Manufacturer's proprietary liner panels with moisture-and mold-resistant core and surfaces; comply with ASTM D 3273.
   a) Core: 1 inch thick.
   b) Long Edges: Double bevel.

B. Gypsum Board: As specified in Division 09 Section "Gypsum Board."

C. Water-Resistant Gypsum Backing Board: As specified in Division 09 Section "Gypsum Board."

2.06 GYPSUM BOARD SHAFT-WALL ASSEMBLIES

A. Fire-Resistance Rating: As indicated.

B. STC Rating: As indicated.

C. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

1. Depth: As indicated.
2. Minimum Base Metal Thickness: Manufacturer's standard thicknesses that comply with structural performance requirements for stud depth indicated.

D. Runner Tracks: Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches long and in depth matching studs.

1. Minimum Base Metal Thickness: Thickness based on structural capabilities tabulated in manufacturer's literature and on Project conditions, but no less than 20-gauge base metal thickness.

E. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches, in depth matching studs.

F. Cavity Insulation: Sound attenuation blankets, where indicated on drawings.

2.07 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
   a) Corner bead: Use at outside corners.
   b) Bullnose Bead: Use at outside corners.

c) LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges.
d) L-Bead: L-shaped; exposed long leg receives joint compound; use where indicated.
e) U-Bead: J-shaped; exposed short flange does not receive joint compound; use at exposed panel edges.
f) Other shapes as shown on drawings.

2.08 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper reinforcing tape.
2. Tile Backer Units: Polymer coated, open glass fiber mesh tape

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
   a) Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.

D. Joint Compound for Cementitious Backer Unit: Material recommended by cementitious backer unit manufacturer.

2.09 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

D. Acoustical Sealant for Exposed and Concealed Joints: Non-sag, paintable, non-staining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products:
   a) OSI Sealants, Inc.; Pro-Series, SC 175 Acoustical Sound Sealant Non-Flammable-Latex.
   b) Pecora Corporation; AC-20 + Silicone.
   c) Tremco Incorporated; Tremflex 834.
   d) United States Gypsum Co.; SHEETROCK Acoustical Sealant.

E. Backer Plates: 20 gauge steel plate, 6 inches wide, G 60 hot dip galvanized coating complying with ASTM A 525, length as required for fastening to studs and to provide support for wall mounted work.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLING STEEL FRAMING, GENERAL

A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

1. Isolate ceiling assemblies where they abut or are penetrated by building structure.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

3.03 INSTALLING STEEL SUSPENDED CEILING AND SOFFIT FRAMING

A. Suspend ceiling hangers from building structure as follows:

1. 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. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counters playing, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install 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 by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyes crews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
4. Secure rod or angle hangers to structure, including intermediate framing members, by attaching to inserts, eyes crews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Installation Tolerance: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 20 feet measured lengthwise on each member and transversely between parallel members

C. Sway-brace suspended steel framing.

D. Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

E. Install suspended steel framing components in sizes and spaces indicated, but not less than that required by the referenced steel framing and installation standards.

1. Wire Hangers: 0.1620 inch (8 gauge) diameter, maximum 4 feet o.c. in direction of main runner channels, at right angles to main runners, and within 6 inches of ends of main runner ends and of boundary wall, girders, and interruptions in ceiling continuity..
2. Carrying Channels (Main Runners): 1-1/2 inch, 4 feet o.c. Do not allow main runner in contact with abutting masonry walls. Locate runner channels within 6 inches of walls to support ends of furring channels.
3. Rigid Furring Channels (Furring Members): 16 inches o.c. Do not allow contact with masonry walls. Provide end splices by nesting channels of studs minimum 8 inches and wire tire securely.
4. Furring Channel Clips: Install on alternate sides of main runner channels. Wire tie metal furring channel to 1-1/2 inch channel when clips cannot be alternated and to main support members.

F. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.04 INSTALLING STEEL PARTITION FRAMING

A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction:

B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.

C. Sway-brace suspended steel framing.

D. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. Cut studs 1 inch short of full height to provide perimeter relief.
2. For fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.

E. Install steel studs and furring at the following spacings:

1. Single-Layer Construction: 16 inches o.c., unless otherwise indicated
2. Multi-Layer Construction: 16 inches o.c., unless otherwise indicated.

F. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.

G. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Install two studs at each jamb, unless otherwise indicated.
2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.
3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above

H. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

3.05 INSTALLING GYPSUM SHAFT WALL

A. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:

1. ASTM C 754 for installing steel framing except comply with framing spacing indicated.
2. Division 09 Section "Gypsum Board" for applying and finishing panels.

B. Do not bridge architectural or building expansion joints with shaft-wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.

1. At elevator hoistway entrance door frames, provide jamb struts on each side of door frame.
2. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312-inch minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 face-layer panel.

D. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.

E. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

F. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.

G. Install control joints to maintain fire-resistance rating of assemblies.

H. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.

I. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.06 APPLYING AND FINISHING PANELS, GENERAL

A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

1. Install sound attenuation blankets over tops of partitions where partitions are indicated less than full height and include sound attenuation blankets in the partition. Extend blankets horizontally 4 feet on both sides of partitions.
2. Sound attenuation partitions: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Close off sound-flanking paths around or through partitions, including sealing partitions above acoustical ceilings.

C. For soffits, install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each soffit. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

E. 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.

F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. Attach gypsum panels to framing provided at openings and cutouts.

H. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

3.07 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On ceilings, apply gypsum panels at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a) Stagger abutting end joints not less than one framing member in alternate courses of board.
b) At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

B. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for 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 indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions

C. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

D. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws

3.08 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Install corner beads at external corners.

C. Install edge trim where edge of gypsum panels would otherwise be exposed or semi exposed. Provide edge trim type with face flange formed to receive joint compound except where other types are indicated.

1. Install LC bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
2. Install L bead where edge trims can only be installed after gypsum panels are installed.
3. Install U bead where indicated.
4. Install aluminum trim and other accessories where indicated.

D. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by the Owner Representatives for visual effect

3.09 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, edge trim, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840.

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire resistive rated assemblies and sound rated assemblies
2. Level 4: All panel surfaces exposed to view; embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated

3.10 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner suitable to Installer, that ensures gypsum board assemblies remain without damage or deterioration at time of Substantial Completion.

C. Prior to installation of ceiling, stencil fire rating of each rated partition above ceiling line. Stencil rating every 10 feet using permanent paint

END OF SECTION 09260

SECTION 09300 - CERAMIC TILE

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ceramic tile.
2. Stone thresholds.
3. Waterproof membrane.
4. Crack isolation membrane.
5. Metal edge strips.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples:

1. Each type and composition of tile and for each color and finish required.
2. Assembled samples, with grouted joints, for each type and composition of tile and for each color and finish required.

1.03 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.04 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of each type of floor tile installation.
2. Build mockup of each type of wall tile installation.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2. PRODUCTS

2.01 TILE PRODUCTS

A. ANSI Ceramic Tile Standard: Provide Standard grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. FloorScore Compliance: Tile for floors shall comply with requirements of FloorScore Standard.

C. Tile Type PS: Glazed paver tile.

1. Basis-of-Design Product:

a) Floor Tile – 12”x12” Daltile Continental Slate Porcelain Floor Tile – color as indicated on drawings.

b) Wall Base – 6”x12” Daltile Continental Slate Porcelain Floor Tile wall base – color as indicated on drawings.

2. Subject to compliance with requirements, provide comparable product by one of the following:

a) American Marazzi Tile, Inc.

b) American Olean; Division of Dal-Tile International Inc.

c) Florida Tile.

d) Crossville Tile.

3. Thickness: 5/16” for Daltile Continental Slate Porcelain Floor Tile.

4. Face: Pattern of design indicated, with square edges.

5. Tile Pattern: As indicated on the drawings.

6. Grout Color: Laticrete, color: 24 Natural Gray.

7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as required, selected from manufacturer’s standard shapes.

2.02 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16” above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2” or less above adjacent floor surface.

B. Marble Thresholds: ASTM C 503, with minimum abrasion resistance per ASTM C 1353 or ASTM C 241 and with honed finish.

1. Description: As selected by owner’s representative if required.

2.03 CRACK ISOLATION MEMBRANE

A. General: Manufacturer’s standard product, that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

1. Products: Subject to compliance with requirements, provide one of the following:

a) Custom Building Products; Redgard Waterproofing and Crack Prevention Membrane

b) Southern Grouts & Mortars, Inc.; Southcrete 1100 Crack Suppression and Waterproofing.

c) TEC, a subsidiary of H. B. Fuller Company; HydraFlex - Waterproofing Crack Isolation Membrane.

d) Mapei, Aquadefense – Waterproofing Crack Isolation Membrane.

2.04 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

1. Basis-of-Design Product: Subject to compliance with requirements, provide “Mapei – UltraContact Mortar for floors and Mapei UltraLight Mortar for walls” or comparable product by one of the following:

a) Boiardi Products; a QEP company.

b) Bonsal American; an Oldcastle company.

c) Bostik, Inc.

d) C-Cure.

e) Custom Building Products.

f) Jamo Inc.

g) Laticrete International, Inc.

h) MAPEI Corporation.

i) Mer-Kote Products, Inc.

j) Southern Grouts & Mortars, Inc.

k) Summitville Tiles, Inc.

l) TEC; a subsidiary of H. B. Fuller Company.

2. For wall applications, provide non-sagging mortar.

2.05 GROUT MATERIALS

A. Polymer-Modified Tile Grout: ANSI A118.7.

1. Basis-of-Design Product: Subject to compliance with requirements, provide “Mapei Keracolor S Premium sanded Grout with polymer and Van Hurren Grout-Once additive” or comparable product by one of the following:

a) Boiardi Products; a QEP company.

b) Bonsal American; an Oldcastle company.

c) Bostik, Inc.

d) C-Cure.

e) Custom Building Products.

f) Laticrete International, Inc.

g) MAPEI Corporation.

h) TEC; a subsidiary of H. B. Fuller Company.

2.06 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips where required: Angle or L-shape, stainless steel, ASTM A 666, 300 Series exposed-edge material.

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

a) Blanke Corporation.

b) Ceramic Tool Company, Inc.

c) Schluter Systems L.P.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.

3.02 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4" per foot toward drains.

C. Blending: For tile exhibiting color variations, use factory blended tile or blend tiles at Project site before installing.

D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.03 INSTALLATION

A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:

a) Tile floors in wet areas.

b) Tile floors composed of tiles 8" by 8" or larger.

c) Tile floors composed of rib-backed tiles.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated. As much as possible, use full tiles at areas exposed to view and locate partial tiles at areas screened or hidden under equipment and fixtures.

F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Floor Tile: 3/16".

G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

I. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

J. Install fiber-cement underlayment and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use

latex-Portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

K. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.

L. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

3.04 INTERIOR TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

1. Tile Installation F125A: Thin-set mortar on waterproofing crack isolation membrane; TCA F125A.

d) Tile Type: FT-1

e) Thin-Set Mortar: Latex-Portland cement mortar.

f) Grout: Polymer-modified sanded grout.

B. Interior Wall Installations, Masonry or Concrete:

1. Tile Installation W202: Thin-set mortar; TCA W202.

a) Tile Type: WT-1, WT-2, WT-3, WT-4, WT-5 & WT-6.

b) Thin-Set Mortar: Latex Portland cement mortar.

c) Grout: Polymer-modified sanded grout.

END OF SECTION 09300

SECTION 09541 – Luminous Canopy Ceilings

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ceiling canopies.

2. Cable hangers and fasteners.

B. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract documents, proposed product substitutions may be submitted prior to the date established for receipt of bids. Acceptability of a proposed substitution is contingent upon the Architect's review of the proposal for acceptability and approved products will be set forth by the Addenda. If included in a Bid are substitute products which have not been approved by Addenda, the specified products shall be provided without additional compensation.

2. Submittals which do not provide adequate data for the product evaluation will not be considered. The proposed substitution must meet all requirements of this section, including but not neccessarily limited to, the following: Single source materials suppliers (if specified in Section 1.5); Panel design, size, composition, color, and finish; suspension system component profiles and sizes; compliance with the referenced standards.

1.02 REFERENCES

A. International Building Code - Chapter 8, Chapter 26

B. NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

1.03 SUBMITTALS

A. Product Data: Manufacturers standard data sheets listing dimensions and details.

B. Installation Instructions: Submit manufacturer's installation instructions.

C. Samples: Manufacturers standard samples including suspension, panels and colors.

D. Shop Drawings: Reflected ceiling plan and elevation drawings indicating ceiling layouts, dimensions and perimeter conditions.

E. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.

1.04 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide canopies and method of attachment by a single manufacturer.

B. Coordination of Work: Coordinate canopy work with installers of related work including, but not limited to suspended ceilings, building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

C. Decorative Ceiling canopies or panels, as with other architectural features located at the ceiling, may obstruct or skew the planned fire sprinkler water distribution pattern, or possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and supression systems are present.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver canopies to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing canopies, permit them to reach room temperature and a stabilized moisture content.

C. Handle canopies carefully to avoid damaging units in any way.

1.06 PROJECT CONDITIONS

A. Verify weather tightness of area to receive suspension system prior to installation.

B. Wet trades work to be thoroughly dry and complete prior to suspension system installation.

C. Installation to begin only when temperature and humidity conditions closely approximate interior conditions which will exist when area is complete and occupied.

D. Heating and air conditioning systems to be operating prior to, during, and after installation.

1.07 WARRANTY

A. Ceiling canopy: Submit a written warranty executed by the manufacturer, agreeing to repair or replace canopies that fail within the warranty period. Failures include, but are not limited to:

1. Canopies: Manufacturer's defects.

2. Attachment devices: Rusting and manufacturer's defects.

B. Warranty Period:

1. Canopies: One (1) year from date of substantial completion.

2. Attachment devices: One (1) year from date of substantial completion.

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Ceiling Canopies and attachement devices:

1. CurvGrid One-Directional Curvilinear Ceiling as manufactured by Chicago Metallic Corporation or comparable product from USG.

2.02 SUSPENSION CEILING CANOPY SYSTEM COMPONENTS

A. Primary Carrier:

1. Manufactured from 0.028 inch thick steel rollformed to 1-1/4 inch diameter and factory notched to locate main tees. Includes hanger clamps, splice plates, attachment clips and fasteners

2. Finish: Baked-on wash coat paint

B. Main Tees:

1. Manufactured from cold rolled steel formed to 15/16 inch wide exposed face x 1 ½ inch height. Curved to radii shown on plans and details without visible crimping. Ends of tees to be factory cut to length and notched to provide flush fit to perimeter trim.

2. Finish: Painted on exposed face in 44 Satin Silver Metallic.

C. Perimeter Treatment Components:

1. CurvTrim: Manufactured from extruded aluminum channel ¾ inch wide face x 2 1/8 inch height, straight and curved to match main tees. CurvTrim replaces CurvGrid suspension at perimeters and requires splice plates, corner splice plates and grid attachment clips. Splices to be butt joint and corners to be mitered without using separate corner units or cover caps.

D. Suspension:

1. Hanger Wire: standard galvanized.

E. Flexible Infill Panels:

1. 24 inch x 48 inch nominal size and hold down clips as required including (437.00) hold down inserts at CurvTrim and (445.00) at panel to panel joints.

2. Metal: manufactured from 0.032 inch aluminum, Perforated with CMC pattern “E”. Painted: 44 Satin Silver. Perforated panels to include Soundtex non-woven acoustical fiber bonded to the inside surface.

PART 3. EXECUTION

3.01 PREPARATION

A. Measure each ceiling area and establish layout of canopies. Comply with reflected ceiling plans. Coordinate panel layout with mechanical, electrical and sprinkler fixtures.

3.02 INSTALLATION

B. Install canopies in accordance with the most current manufacturer’s instructions and in compliance with the authorities having jurisdiction.

3.03 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of canopies per installation instructions.

END OF SECTION 09541

SECTION 09580 - SUSPENDED DECORATIVE GRIDS

PART 1. GENERAL

1.01 SUMMARY

A. Section includes rigid, open-frame, suspended grids and suspension systems for ceilings.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.05 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical ceiling area as shown on Drawings.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2. PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 450 or less.

2.02 SUSPENDED DECORATIVE GRIDS, GENERAL

A. Recycled Content of Suspended Decorative Grid Ceiling: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Sheet Metal Characteristics: Provide sheet metal selected for surface flatness, smoothness, and freedom from surface blemishes where exposed to view in finished unit. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, variations in flatness exceeding those permitted by referenced standards for stretcher-leveled metal sheet, stains, discolorations, or other imperfections.

1. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209; alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C 635/C 635M.

a) Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A 879/A 879M, 13Z coating, surface treatment as recommended by finish manufacturer for type of use and finish indicated.

b) Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A 1008/A 1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.

C. Grid Fabrication: Components are formed from metal indicated. Manufacturer's standard units of size, shape, and profile indicated; finished to comply with requirements indicated.

D. Cover Profiles and Trim: Provide manufacturer's standard cover profiles and trim for exposed members, and as indicated or required, for edges of grids, at changes in ceiling height, and for other conditions, of same metal and finish as suspended decorative grids.

E. Metal Suspension-System Standard: Comply with ASTM C 635/C 635M.

F. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635/C 635M, Table 1, Direct Hung, unless otherwise indicated.

2.03 ALUMINUM GRID UNITS FOR SUSPENDED DECORATIVE GRIDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong METALWORKS Open Cell Lay-in Panels Smooth texture in Armstrong Superfine 9/16” Exposed Tee Grid with Armstrong Flex Molding where required or comparable product by one of the following:

1. American Decorative Ceilings.

2. Chicago Metallic Corporation;.

3. Hunter Douglas Architectural Products, Inc.

4. Simplex Ceilings, a division of Intalite Inc.

5. Steel Ceilings Inc.

B. Sheet Metal Thickness: Not less than 0.016”.

C. Cell Panel Module: 24” square.

D. Cell Module: 8” square.

E. Cell Profile, Width by Height: 9/16” by 1/2”.

F. Finish: Painted in color selected from manufacturer's full range.

2.04 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.05 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Clear Mirror Anodic Finish: AA-M21C12A212, Class II, 0.005 mm or thicker.

C. Color-Coated Finish: Manufacturer’s standard powder-coat baked paint complying with coating manufacturer’s written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

D. Bright-Reflective Finish: Manufacturer’s standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness.

2.06 METALLIC-COATED STEEL SHEET FINISHES

A. Color-Coated Finish: Manufacturer’s standard powder-coat baked paint complying with coating manufacturer’s written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

2.07 STEEL SHEET FINISHES

A. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness.

B. Bright-Reflective Finish: Manufacturer’s standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness.

PART 3. EXECUTION

3.01 INSTALLATION

A. General: Install suspended decorative grids to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA’s “Ceiling Systems Handbook.”

B. Install suspended decorative grids in coordination with suspension system and exposed moldings and trim. Comply with installation tolerances according to CISCA’s “Metal Ceilings Technical Guidelines.”

END OF SECTION 09580

SECTION 09653 - RESILIENT BASE AND ACCESSORIES

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Resilient base.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50° F or more than 90° F.

1.04 PROJECT CONDITIONS

A. Maintain temperatures within range recommended by manufacturer, but not less than 70° F or more than 95° F, in spaces to receive floor tile during the following time periods:

1. 48 hours before installation.

2. During installation.

3. 48 hours after installation.

B. After post installation period, maintain temperatures within range recommended by manufacturer, but not less than 55° F or more than 95° F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2. PRODUCTS

2.01 VINYL BASE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.

2. Burke Mercer Flooring Products, Division of Burke Industries Inc.

3. Flexco.

4. Johnsonite; A Tarkett Company.

5. Roppe Corporation, USA.

6. VPI, LLC, Floor Products Division.

B. Product Standard: ASTM F 1861, Type TV (vinyl, thermoplastic).

1. Group: I (solid, homogeneous).

2. Style and Location:

a) Style A, Straight: Provide in areas with carpet tile

b) Style B, Cove: Provide in areas with resilient flooring

C. Minimum Thickness: 0.125”.

D. Height: 4”.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Preformed.

G. Inside Corners: Preformed.

H. Colors and Patterns: As indicated on drawings.

2.02 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3. EXECUTION

3.01 PREPARATION

A. Prepare substrates according to manufacturer’s written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing.

4. Moisture Testing: Proceed with installation only after substrates pass testing according to manufacturer's written recommendations, but not less stringent than the following:

a) Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3lb of water/1000 sq. ft. in 24 hours.

b) Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are the same temperature as the space where they are to be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.02 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.03 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer’s written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.04 CLEANING AND PROTECTION

A. Comply with manufacturer’s written instructions for cleaning and protecting resilient products.

B. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.

C. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09653

SECTION 10200 - LOUVERS, VENTS AND SCREENS

PART 1. GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Fixed, extruded-aluminum louvers.

B. Related Sections include the following:

1. Division 7 Section “Joint Sealants” for sealants installed in perimeter joints between louver frames and adjoining construction.

2. Division 15 Sections for louvers and vents that are part of mechanical equipment.

1.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide louvers, vents and screens capable of withstanding the effects of gravity loads and wind loads based on a uniform pressure of 30 lbf/sq. ft. acting inward or outward, without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.

B. Thermal Movements: Provide louvers, vents and screens that allow for thermal movements resulting from a temperature change (range) of 120° F, ambient; 180° F, material surfaces, by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

C. Air-Performance, Water-Penetration, and Wind-Driven Rain Ratings: As demonstrated by testing manufacturer's stock units according to AMCA 500-L.

1.03 QUALITY ASSURANCE

A. Louvers licensed to bear AMCA Certified Ratings Seal. Ratings based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

1. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

2. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of metal finish required.

E. Product test reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.

C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Airolite Company

2. Construction Specialties, Inc.

3. Greenheck.

4. Ruskin Company; Tomkins PLC.

C. Basis-of-Design Product: The design for each louver is based on product listed. Subject to compliance with requirements, provide the named product or a comparable product by one of the other manufacturers specified.

2.02 MATERIALS

A. Aluminum Extrusions: ASTM B 221 alloy 6063-T6 or T-52.

B. Aluminum Sheet: ASTM B 209 alloy 3003 or 5005.

C. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel.

2.03 FABRICATION, GENERAL

A. Fabricate frames to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

B. Join frame members to each other and to louver blades with fillet welds concealed from view.

C. Join frame members to each other and to louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view.

2.04 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Double Drainable-Blade Louver

1. Basis-of-Design Product: Ruskin ELF6425DD Continuous Drainable Stationary Louver or a comparable product of one of the above listed manufacturers.

2. Frame:

a) Material: Extruded aluminum, Alloy 6063-T6.

b) Wall Thickness: 0.081”, nominal.

c) Depth: 6”.

d) Downspouts and caulking surfaces.

3. Extended Sills: Extruded aluminum, Alloy 6063-T6. Minimal nominal thickness 0.060 inch.

4. Blades:

a) Style: double drainable with continuous leading edge.

b) Material: Extruded aluminum, Alloy 6063-T6.

c) Wall Thickness: 0.081”, nominal

d) Angle: 42.5°.

e) Centers: 5”, nominal

5. Gutters: Dual drain gutters in each blade.

6. Downspouts: Downspouts in concealed mullions to drain water from louver for minimum water cascade from blade to blade.

7. Concealed Mullions recessed 2” from exterior and placed at 120” to drain blade butters without interruption of the leading edge of the blades.

8. Vertical Supports: Hidden vertical supports to allow continuous line appearance up to 240”.

9. Assembly: Factory assemble louver components.

10. Performance Requirements:

a) Net Free Area: Not less than 49 percent.

b) Point of Beginning Water Penetration at 0.01oz./sq. ft.: 852fpm (free area velocity)

c) Air Performance: Not more than 0.10-inch wg static pressure drop at 800-fpm free-area velocity.

11. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.05 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.

2. Screening Type: Bug screening.

B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6” from each corner and at 12” o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.

2. Finish: Same finish as louver frames to which louver screens are attached.

3. Type: Rewirable frames with a driven spline or insert for permanently securing screen mesh.

2.06 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: 2”.

2. Metal Facing Sheets: Aluminum sheet, not less than 0.032” nominal thickness.

3. Insulating Core: Foamed-plastic rigid insulation board.

4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer’s standard extruded-aluminum-channel frames, not less than 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” PVC compression gaskets.

6. Panel Finish: Same finish applied to louvers.

7. Attach blank-off panels to back of louver frames with stainless-steel, sheet metal screws.

2.07 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

B. High-Performance Organic-Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Fluoropolymer Three-Coat Coating System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

d) Color and Gloss:

1) Horizontal Louvers: Custom color to match metal wall panels.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION

A. Locate and place louvers, vents and screens level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

E. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

3.04 ADJUSTING AND CLEANING

A. Clean exposed surfaces of louvers, vents and screens that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers, vents and screens damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by A/E, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 10200

SECTION 10523 - FIRE EXTINGUISHERS

PART 1. GENERAL

1.01 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

C. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a) Failure of hydrostatic test according to NFPA 10.

b) Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2. PRODUCTS

2.01 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Amerex Corporation.

b) Ansul Incorporated; Tyco International Ltd.

2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

C. Clean-Agent Type in Steel Container: UL-rated, 1-A:10-B:C, 10-lb nominal capacity, with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage.

2.02 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Amerex Corporation.

b) Ansul Incorporated; Tyco International Ltd.

c) Badger Fire Protection; a Kidde company.

d) Buckeye Fire Equipment Company.

e) Fire End & Croker Corporation.

f) J. L. Industries, Inc.; a division of Activar Construction Products Group.

g) Larsen's Manufacturing Company.

h) Potter Roemer LLC.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a) Orientation: Vertical.

PART 3. EXECUTION

3.01 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54” above finished floor to top of fire extinguisher.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10523

SECTION 10800 – TOILET ACCESSORIES

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Washroom accessories.
2. Under lavatory guards.
3. Custodial accessories.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify products using designations indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.05 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same articles in Part, provide products of same manufacturer unless otherwise approved by the architect.

1.06 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

1.07 COORDINATION

A. Coordinate 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 accessories.

PART 2. PRODUCTS

2.01 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.0312” minimum nominal thickness, unless otherwise indicated.

B. Brass: ASTM B 19 flat products; ASTM B 16 rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.

C. Steel Sheet: ASTM A 1008 Designation CS (cold rolled, commercial steel), 0.0359” minimum nominal thickness.

D. Galvanized Steel Sheet: ASTM A 653, with G60 hot-dip zinc coating.

E. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.

F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

2.02 WASHROOM ACCESSORIES

A. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

1. A & J Washroom Accessories, Inc.

2. American Specialties, Inc.

3. Bobrick Washroom Equipment, Inc.

4. Bradley Corporation.

B. Toilet Tissue Dispenser

1. Basis-of-Design Product: American Specialties, Inc. 20030 Surface Mounted Twin Hide-a-roll Toilet Tissue Dispenser.

2. Series: Roval

3. Lock: Tumbler

4. Mounting: Surface Mounted.

C. Grab Bar:

1. Basis-of-Design Product: A.S.I. 3800 P Series.

2. Mounting: Flanges with concealed fasteners.

3. Material: Stainless steel, 0.05” thick.

a) Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.

4. Outside Diameter: 1-1/2”.

5. Configuration and Length: Straight, various lengths as shown on plans.

D. Sanitary Napkin Disposal (Feminine Hygiene Disposals):

1. Basis-of-Design Product: A.S.I. 20852 Series.

2. Mounting: Surface.

3. Series: Roval.

4. Material: Stainless steel.

5. Size: 7-1/4”x10”x3-1/2”

E. Paper Towel Dispenser:

1. Basis-of-Design Product: A.S.I. 20210 Series.

2. Description: Surface mounted 400 C-fold paper towel dispenser.

3. Mounting: Surface.

4. Material: 22 gauge Type 304 stainless steel.

5. Lock: Tumbler.

6. Size: Dispenses 400 C-fold or 525 multi-fold paper towels.

F. Above Sink Mirror Unit:

1. Basis-of-Design Product: A.S.I. #20655, with theft resistant back plate and shelf.

2. Series: Roval.

3. Mounting: Surface with tamperproof mounting mechanism

4. Material: 18 gauge type 304 stainless.

5. Glass: 1/4” tempered glass.

6. Options: with shelf

7. Size: Size as indicated on drawings

G. Soap Dispenser:

1. Basis-of-Design Product: A.S.I. #20364

2. Description: Surface mounted automatic foam soap dispenser.

3. Mounting: Surface.

4. Series: Roval.

5. Material: 22 gauge type 304 stainless

6. Capacity: 33.8 oz.

7. Operation: Sensor.

8. Options: Provide starter kit with soap and batteries.

H. Shelf and Mop-hook (Provide in Janitor’s Closet):

1. Basis-of-Design Product: A.S.I. 1315-3 Series.

2. Mounting: Surface.

3. Material: Stainless steel.

4. Description: Utility shelf with three mop holders, 2 rag hooks, and rod, 30” long.

I. Not Used.

J. Under lavatory Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Plumberex Specialty Products, Inc.

b) TCI Products

c) Truebro Inc.

2. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping, and allow service access without removing coverings.

3. Material and Finish: Antimicrobial, molded-plastic, white

K. Freestanding Refuse Container:

a) Basis-of-Design Product: A.S.I. 0812 Series .

b) Mounting: Freestanding.

c) Material: Stainless steel.

d) Description: Stainless Steel Free Standing Waste Receptacle

e) Specification: 19 gal. Capacity with stainless steel swing top.

2.03 Fabrication

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3. EXECUTION

3.01 Installation

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbs when tested according to ASTM F 446.

END OF SECTION 10800

SECTION 12494 – ROLLER SHADES

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes: Interior roller-screen sunscreen including accessories.

B. Related Work:

1. Section 06100 - Rough Carpentry.

1.02 PERFORMANCE REQUIREMENTS

A. Fire-Performance Characteristics: Provide shade material tested in accordance with NFPA 701 - Vertical-Burn Test and rated "PASS."

1.03 SUBMITTALS

A. Product Literature: Manufacturer's product data sheets, specifications, performance data, physical properties and installation instructions for each item required.

B. Shop Drawings: Submit large-scale detail drawings, including actual measurements taken at the project. Include complete fabrication details and erection drawings.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Minimum of 3 years documented experience demonstrating previously successful work of the type specified herein, and approved by window shade manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver prefabricated shades to site in labeled protective packages, uniquely identified for each intended location. Schedule delivery to prevent delays but minimize on-site storage.

B. Store materials in manner recommended by shade manufacturer, inside, under cover, and in manner to keep shades dry, protected from weather, surface contamination, corrosion and damage from construction traffic and other causes.

PART 2. PRODUCTS

2.01 BASIS-OF-DESIGN MANUFACTURER and PRODUCT

A. Manufacturer: Mecho Shade Systems, Inc., Long Island City, NY. Or approved equal.

B. Product: Mecho/5 – manual operating, chain drive, sunscreen roller shades in exterior windows of rooms and spaces shown on the Drawings or approved equal.

2.02 SHADECLOTH MATERIALS

A. Sun-shade cloth: MechoSystems Thermoveil 2100-Series (10 percent open) Color: 2113 Grey or approved equal.

2.03 SHADE-ROLLER COMPONENTS

A. General: All hardware shall be available with regular drive and offset drive, and be reversible for left or right hand operation. Offset drive chain assembly shall place both operating chains at the same location at the shadecloth, or to the rear of the shadecloth out of sight. Hardware shall be operable with or without blackout side channels.

B. Shade Roller: Extruded-aluminum tube 6063-T5 alloy, with a minimum wall thickness of 0.065 inch and an internal keyway to receive manual drive or tubular motor where required. The tube shall be extruded with two fabric-mounting channels designed so that the shadecloth does not disengage from the tube itself. Shade rollers shall be reversible for left-or right-hand operation.

C. Shade Mounting Spline: Extruded vinyl "SnapLoc" spline with asymmetrical insertion-locking channels and embossed-shadecloth guide, enabling shadecloth to be removed without having to remove the tube from retainer bracketsor without removing brackets from wall.

D. Tube Support: Delrin cover plate to provide protection from tube's dislocation. In the event the tube is pushed out of place, the Delrin end of the mounting plates shall contain the tube preventing the tube from falling out of the bracket.

2.04 MOUNTING SYSTEM MATERIALS

A. Mounting System: Minimum 1/8” sheet to which drive assembly, idle-end assembly and center-support systems are attached.

1. Components of brackets, inside or outside mount, shall be interchangeable or replaceable without removing bracket from wall or ceiling. Use Slimline Bracket.

2.05 ACCESSORIES

A. SnapLoc Fascia panel.

2.06 FABRICATION

A. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.

B. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8”.

2.07 FACTORY FINISHES

C. Aluminum Components: (PPG Duracon baked enamel in standard colors) (Anodized finishing selected color)

D. Steel Components: Cadmium-plated, satin-finished, or bonderized prior to painting with baked-enamel finish.

2.08 MANUAL OPERATION

A. General: Bi-directional clutch and bead-chain mechanism with adjustable brake to permit:

1. Static mode with infinite stop positions as required. Single-mode shade operators shall not be acceptable.

2. Sprocket: One-piece, injection-molded, high-density Delrin capable of full engagement with stainless-steel bead chain qualified to match the pitch of the sprocket.

3. Chain: Qualified No. 10 stainless steel, 90-lb test. Nickel-plated brass-bead or steel-based control-loop chain and plastic-bead chain are not acceptable.

4. Brake Mount: Vibration-proof steel and vibration-resistant nylon locking nut to maintain selected braking friction.

5. Brake adjustment shall be concealed within the shade operating tube, with vibration-resistant locking-nut assembly.

6. Disc Brake: Self-adjusting linear disc brake with concealed-tension adjustment device.

    a. System shall consist of a compression spring with two friction-absorbing nylon washers on a 1/4” steel shaft that provides continuous, uniform, compensating brake pressure on the one-piece-sprocket, brake-drive component with a braking surface of not less than 2.89 square inches.

    b. Provide a compression spring, which also acts as a vibration absorber.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine substrate and conditions for installation. Notify the Architect in writing prior to installation when the project conditions are unacceptable for shade installation. "Beginning of Installation," means acceptance of substrate and project conditions.

3.02 INSTALLATION

A. Install units to comply with the Manufacturer's instructions for the type of mounting and operation required. Provide units plumb, true, and securely anchored in place with recommended hardware and accessories to provide smooth operation without binding.

3.03 ADJUSTING

A. Adjust units for smooth operation. Adjust shade and shadecloth to hang flat without buckling or distortion. Replace any units or components, which do not hang properly or operate smoothly.

3.04 CLEANING

A. Touch up damaged finishes and repair minor damage in order to eliminate evidence of repair. Remove and replace work that cannot be satisfactorily repaired.

B. Clean exposed surfaces, including metal and shadecloth, using non-abrasive materials and methods recommended by the Shadecloth Manufacturer. Remove and replace work, which cannot be satisfactorily cleaned.

3.05 DEMONSTRATION

A. Demonstrate operation method and instruct Owner's personnel in the proper operation and maintenance of the window shade systems.

END OF SECTION 12494

SECTION 14240 – HYDRAULIC ELEVATOR

PART 1. GENERAL

1.01 SUMMARY

A. Section includes hydraulic passenger elevators.

1.02 ACTION SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment.

2. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples: For exposed finishes.

1.03 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard One-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.05 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide ThyssenKrupp AMEE 45 Series Twinpost Telescopic (2-Stage) Holeless Hydraulic Elevator or comparable product by one of the following:

1. Otis Elevator Co.

2. Schindler Elevator Corp.

2.02 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. MCE Spectral Response Acceleration Values: (Zip Code 50501):

Sms=0.104 Sm1=0.085
Sds=0.070 Sd1=0.058

2.03 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Group Number: One.

2. Elevator Number: 1.

3. Type: Holeless, beside-the-car, single-acting, dual cylinder.

4. Rated Load: 4500 lb.

5. Rated Speed: 80 fpm

6. Operation System: Single automatic .

7. Auxiliary Operations:

   a) Auxillary power to be provided by building generator.

   b) Independent service.

   c) Elevator to be locked out from service with key-switch at the ground floor lobby.

8. Car Enclosures:

   a) Inside Width: 93-1/2” from side wall to side wall.

   b) Inside Depth: 68” from back wall to front wall (return panels).

   c) Inside Height: 88” to underside of ceiling.

   d) Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.

   e) Car Fixtures: Satin stainless steel, No. 4 finish and lexan.

   f) Side and Rear Wall Panels: Enameled steel with removable plastic laminate panels.

   g) Reveals: Enameled steel

   h) Door Faces (Interior): Satin stainless steel, No. 4 finish.

   i) Ceiling: Luminous ceiling with powder coat exposed frame with lay-in panels and fluorescent lighting. The frame finish is powder coat and the lay-in panels shall be removable flat, translucent, non-combustible Lexan panels.

   j) Handrails: ½” by 2” rectangular at sides and rear of car.

   k) Floor Finish: Rubber Floor Tile, ASTM F1344 over underlayment grade, exterior plywood, 5/8-inch nominal thickness.

9. Hoistway Entrances:

   a) Width: 48”.

   b) Height: 84”.

   c) Type: Single-speed side sliding.

   d) Frames: Satin stainless steel, No. 4 finish.

e) Doors: Satin stainless steel, No. 4 finish.

10. Hall Fixtures Stainless Steel and mounted per ADA requirements.

11. Additional Requirements:

a) Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.

b) Provide hooks for protective pads and one complete set of full-height protective pads.

c) Provide additional CAT-5 cable from inside cab (at control panel) to inside the machine room for future card-reader installation, provide additional 6 feet of cable on each end.

2.04 SYSTEMS AND COMPONENTS

A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.

1. Pump shall be submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts.

2. Motor shall have solid-state starting.

B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.

C. Hydraulic Fluid: Elevator manufacturer's standard fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.

D. Guides: sliding guides with guide-rail lubricators. Provide guides at top and bottom of car.

2.05 OPERATION SYSTEMS

A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.

B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:

2.06 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car

entrance. Interruption of one or more light beams shall cause doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.07 CAR ENCLOSURES

A. General: Provide enameled-steel car enclosures to receive removable wall panels, with car roof, access doors, power door operators, and ventilation.

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Enameled-Steel Wall Panels: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.

2. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2” fire-retardant-treated particleboard with plastic-laminate panel backing and manufacturer's standard protective edge trim. Panels have a flame-spread index of 75 or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected by Architect from plastic-laminate manufacturer's full range.

3. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet

4. Sills: Extruded aluminum, with grooved surface, 1/4” thick.

5. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.

6. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated

7. Subfloor: Underlayment grade, exterior plywood, 5/8” nominal thickness.

8. Floor Finish: Rubber Floor Tile, ASTM F1344.

a) Manufacturer: Subject to compliance with requirements provide product by Perelli Rubber Flooring or a comparable product by another manufacturer.

b) Class: I-A homogeneous rubber tile, solid color.

c) Hardness: Not less than required by ASTM F 1344.

d) Wearing Surface: Molded Pattern, Raised Discs.

e) Thickness: 0.125”.

f) Size: 12” by 12”.

g) Color: As selected by Architect from manufacturer full range of colors.

2.08 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to UL 10B.

2. Fire-Protection Rating: 1 hour with 30-minute temperature rise of 450° F.

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Enameled-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.

2. Stainless-Steel Frames: Formed from stainless-steel sheet.

3. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet

4. Sills: Extruded aluminum, with grooved surface, 1/4” thick.

5. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.09 SIGNAL EQUIPMENT

A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with LEDs.

B. Car-Control Stations: Provide manufacturer's standard car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Provide "No Smoking" sign matching car-control station, with text and graphics as required by authorities having jurisdiction.

C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Car Position Indicator: Provide illuminated, digital-type car position indicator, Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

E. Hall Push-Button Stations: Provide hall push-button station at each landing as indicated and mounted in the door jambs.

F. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

D. Stainless-Steel Bars: ASTM A 276, Type 304.

E. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

F. Aluminum Extrusions: ASTM B 221, Alloy 6063.

G. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS or Type HGL

H. Rubber Floor Tile: SEE SECTION 2.07- B8.

PART 3. EXECUTION

3.01 INSTALLATION

A. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

B. Lubricate operating parts of systems as recommended by manufacturers.

C. Leveling Tolerance: 1/4”, up or down, regardless of load and travel direction.

D. Set sills flush with finished floor surface at landing. Fill space under sill solidly with non-shrink, nonmetallic grout.

3.02 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

3.03 PROTECTION

A. Temporary Use: Do not use the elevator for temporary construction use. If general contractor requires the use of the elevator for temporary use, they are to execute a Temporary Use Agreement with the elevator subcontractor.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate elevator.

3.05 MAINTENANCE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 14240

SECTION 14430 BRIDGE CRANE INSTALLATION

PART 1. GENERAL

1.01 SCOPE

A. INCLUDED: All labor, materials, and equipment to unload, erect, and test the two (2) 30 - ton bridge cranes.

B. RELATED WORK SPECIFIED ELSEWHERE: Provide crane rails and accessories as specified under Section 05500 METAL FABRICATIONS.

C. RELATED WORK: Examine all other portions of the Subcontract documents for work related to the work of this Section. Provide all work required for the support and accommodation of related work.

1.02 FERMILAB FURNISHED MATERIALS AND SERVICES

A. FERMILAB FURNISHED MATERIAL: The two (2) 30-ton bridge crane will be furnished to the Subcontractor. Crane will be delivered to the Mu2e Conventional Facilities site by the crane manufacturer for off-loading by the Subcontractor. Delivery will be coordinated with Subcontractor's installation schedule. Major components include the two end-trucks, the drive and idler girders and the trolley. The trolley will come unreeved.

Approximate total weight of each assembled crane is 46,000 lbs. The runway conductors and brackets will be furnished with the crane for the Subcontractor to install.

B. FERMILAB FURNISHED SERVICES: The crane manufacturer will furnish the services of a qualified crane erection engineer for a period of two (2) days for each crane to assist the Subcontractor during crane erection. Additionally the crane manufacturer will provide a qualified crane erection engineer to assist and monitor the load test. This service will be at no cost to the Subcontractor. Five (5) days' notice shall be given to Fermilab in order to have the erection engineer on site when he is needed.

1.03 PREPARATION AND ASSEMBLY

A. REMOVE any protective coating applied to crane parts for protection during shipment. Field painting is not required. Touch up painting of damaged spots shall be included.

PART 2. BRIDGE CRANE INSTALLATION

2.01 ALIGN and level the crane rails on the runway girders. Alignment in elevation and center to center of rail span not to exceed+ 1/4". Butt rails tightly together with a maximum difference in elevation or side alignment of 1/32" and a maximum gap

between the rails of 1/16". An excess of elevation must be ground smooth and an excess of gap must be grooved, welded, and ground smooth.

2.02 ASSEMBLE the crane bridge, girders, end trucks, catwalks, etc. Crane will be received by truck, partially disassembled.

2.03 INSTALLATION

A. ERECT BRIDGE, trolley, hoist, and all miscellaneous parts.

B. INSTALL the brackets and four (4) runway conductors and do all field wiring required to make the crane operable. Provide the power feed from the runway conductors to the crane safety switch located near column 2/F. Two additional isolation disconnects will be installed towards the ends of the runway to allow isolation of a crane for servicing.

C. LUBRICATE all bearings, gears, etc. in accordance with manufacturer s recommendations.

2.04 TESTING

A. THE SUBCONTRACTOR shall test the crane, under the supervision of Fermilab, to insure that the stipulated rated capacities and movement requirements have been met. All tests shall be carried out with the cooperation and guidance of Fermilab's engineer. Adjustments, if required, shall be made as directed by the engineer on items such as limit switches, brake adjustments, etc.

Each crane shall be tested to its rated capacity of 30-tons with an overload lifting and holding of 125% of the rated load (37.5 tons).

The steel and concrete test weights required for load testing the crane totaling 37.5 tons are located at the Fermilab Railyard Storage Area. The Subcontractor shall be required to pick up and return the test weights and provide for loading and off loading at the Railyard Storage Area. Only one crane will be load tested a time.

Fabric slings with the required length and capacity for lifting the test weights shall be provided by the Subcontractor. The Subcontractor shall also provide all other required rigging including softeners. All rigging shall new and remain with the FCC.

END OF SECTION 14430

SECTION 15010 - GENERAL PROVISIONS

PART 1. GENERAL

1.01 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the Work of this Section including, but not limited to, all Drawings, all Specifications, Exhibit A, General Conditions, and General Requirements including submittals and related documents.

1.02 SCOPE OF WORK

A. The work of this Section consists of all labor, materials, equipment, transportation, and facilities necessary to provide a complete and satisfactory system ready to use. Whenever the words "the Contractor" appear in this Division, they refer to the Contractor for work specified in that section. The Contractor shall examine ALL Drawings and ALL sections of the Specifications and shall be responsible for ascertaining to what extent other drawings and sections affect the work herein specified.

1.03 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations to expand the requirements specified in Related Documents

B. Division 15 Specifications cover the following work:

1. Plumbing Work is specified in the applicable portions of Division 15 specs:

2. Ventilating Work is specified in the applicable portions of Division 15 specs:

1.04 DEFINITIONS:

A. The following terms shall have the meanings herein designated for each:

1. “Will”: as used herein, is defined as an action by the Engineer, or by others.

2. “Shall”: as used herein, is defined as an action required by the Contractor.

3. “May”: as used herein, is defined as an action that is optional for the Contractor.

4. “Piping”: as used herein, is defined as pipe, fittings, valves, flanges, unions, specialties and accessories and appurtenances necessary for, or incidental to, a complete system.

5. “Ductwork”: as used herein, is defined as all air delivery, re-circulation and exhaust ducts whether of sheet metal or other material, and includes all connections, accessories and appurtenances necessary for and incidental to a complete system.

6. “Provide”: as used herein, is defined as to furnish and install.

7. “Concealed work”: as used herein refers to piping and ductwork above ceilings and within walls, partitions, shafts or service spaces, not normally exposed to view and enclosed on all sides by finish materials. Access to piping and ductwork would be by demolition of finish materials.

8. “Concealed but accessible work”: as used herein refers to piping and ductwork accessible above or through suspended ceilings, in walls at access panels or in chases with access door or man-doors.

9. “Exposed work”: refers to piping or equipment normally exposed to view within rooms or open areas.

10. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

11. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

12. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

13. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

14. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.05 QUALITY ASSURANCE

A. Codes and Standards:

1. All work must be performed in accordance with the requirements of all pertinent Federal and State codes; but if in contradiction to the plans or the specifications, the proposed changes must first be referred to the Engineer for review and approval. Base bid shall include the more stringent of the contradicting methods.

2. All work shall comply with the latest edition of the following codes:

   a. International Building Code.

   b. International Mechanical Code.

   c. International Plumbing Code.

   d. International Energy Conservation Code.

   e. National Fire Protection Code.

   f. SMACNA.

B. All equipment, apparatus and systems shall be rated, tested, fabricated and/or installed with the applicable industry standard mentioned.

1.06 REFERENCE TO STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.

B. Conflicting Requirements: Where compliance with two (2) or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different, but apparently equal, and uncertainties to the Construction Coordinator for a decision before proceeding.

C. Publication Dates: Where the date of issue of a referenced standard is not specified, comply with the standard in effect as of date of Contract Documents.

D. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change and are believed to be but are not assured to be accurate and up to date as of date of Contract Documents.

AABC	Associated Air Balance Council	
	1518 K St., NW	(202) 737-0202
	Washington, DC 20005	(202) 438-4833
ABMA	American Bearing Manufacturers Association	
	1101 Connecticut Ave., NW	(202) 429-5155
	Washington, DC 20036	
AGA	American Gas Association	
	1515 Wilson Blvd.	(703) 841-8400

	Arlington, VA 22209-2402	(703) 841-8406
AMCA	Air Movement and Control Association 30 W. University Drive Arlington Heights, IL 60004	(847)94 0150
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018	(212) 354-3300
ARI	Air Conditioning and Refrigeration Institute 4301 Fairfax Drive Arlington, VA 2203-1627	(703) 524-8800 (703) 528-3816
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, NE Atlanta, GA 30329	(404) 636-8400
ASME	American Society of Mechanical Engineers 345 East 47th St. New York, NY 10017	(212) 705-7722
ASPE	American Society of Plumbing Engineers 3617 Thousand Oaks Blvd. Westlake, CA 91362	(805) 495-7120
ASTM	American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103	(215) 299-5400
AWS	American Welding Society 550 NW 20th Ave. Miami, FL 33126-5671	(305) 443-9353 (305) 443-7559
AWWA	American Water Works Association 6666 W. Quincy Ave. Denver, CO 80235	(303) 794-7711 (303) 794-1440
FM	Factory Mutual Engineering and Research Organization 1151 Providence Hwy. Norwood, MA 02062-5082	(617) 762-4300 (617) 551-3552
IEEE	Institute of Electrical and Electronic Engineers 345 E. 47th St. New York, NY 10017	(212) 705-7900
IRI	Industrial Risk Insurers 85 Woodland St. Hartford, CT 06102-3103	(860) 520-7300 (230) 540-5780

ISA	Instrument Society of America	
	P.O. Box 12277	(919) 549-8411
	Durham, NC 27709-2277	(919) 549-8288
MCAA	Mechanical Contractors Association of America	
	5410 Grosvenor Lane	(301) 897-0770
	Bethesda, MD 20814-2144	
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry	
	127 Park St., NE	(703) 281-6613
	Vienna, VA 22180	
NEC	National Electric Code (Now NFPA)	
NEMA	National Electrical Manufacturers Association	
	2101 L St., NW	(202) 457-8400
	Washington, DC 20037-1526	
NFPA	National Fire Protection Association	
	Batterymarch Park	(617) 770-3000
	Quincy, MA 02169-7454	(617) 984-7090
NSF	National Sanitation Foundation	
	McKinley	(313) 475-8941
	Chelsea, MI 48118	
PDI	Plumbing and Drainage Institute	
	1106 W. 77th St., South Dr.	(317) 251-6970
	Indianapolis, IN 46260-3318	(317) 253-8295
SMACNA	Sheet Metal and Air Conditioning Contractors National Association	
	P.O. Box 70	(703) 790-9890
	Merrifield, VA 22116	
SSPMA	Sump and Sewage Pump Manufacturers Association	
	P.O. Box 647	(847) 559-9233
	Northbrook, IL 60065-0647	(847) 559-9235
SWPA	Submersible Wastewater Pump Association	
	1806 Johns Dr.	(847) 729-7972
	Glenview, IL 60025-1657	(847) 729-3670
TIMA	Thermal Insulation Manufacturers Association	
	29 Bank Street	(203) 324-7533
	Stamford, CT 06901	
UL	Underwriters Laboratories	
	333 Pfingsten Rd.	(847) 272-8800
	Northbrook, IL 60062-2096	(847) 272-8129

WSC	Water Systems Council	
	800 Roosevelt Rd.	(630) 545-1762
	Glen Ellyn, IL 60137-5839	(708) 922-2734

E. Federal Government Agencies: Names and titles of federal government standard or Specification producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard or Specification producing agencies of the federal government. Names and addresses are subject to change; they are believed to be but are not assured to be accurate and up to date as of the date of the Contract Documents:

EPA	Environmental Protection Agency	
	401 M St., SW	(202) 260-2090
	Washington, DC 20460-0003	(202) 260-8168
OSHA	Occupational Safety and Health Administration	
	820 1st St. NE	(202) 523-1452
	Washington, 20002-4243	

1.07 PERMITS AND FEES

A. The Contractor and/or subcontractors shall be required to obtain building permits for the project.

B. Where inspections of the work are required by local authorities, the Contractor shall obtain certificates of inspections of his work by such authorities, and these certificates (in triplicate) shall be submitted to the Engineer before final certificate for payment under his contract will be issued.

1.08 SUBMITTALS

A. General: Submit under the provisions of Exhibit A, Section 12.0 - Submittals, Shop Drawings and Material Samples.

B. Prior to the performance of any work or installation of any materials, obtain approval from the Construction Coordinator by submitting shop drawings and data sheets.

C. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Subcontractor. Data submitted from subcontractors and material suppliers directly to the Construction Coordinator will not be processed.

D. Any items with a tag number must be submitted for approval. Submittals shall provide all pertinent data and information necessary to evaluate each item. Drawings and data sheets shall show:

1. Principal dimensions and details of construction.

2. Weights of principal parts and total weights with information required for the design of sup-ports and foundations.

3. Sizes and locations of piping and connections.

4. Performance data, including pump and fan curves; fan discharge and inlet noise data; certified by the manufacturer for the equipment furnished.

5. Data on electric motors, including break HP of driven equipment, nameplate ratings and classes, and starting and running full load currents.

6. Approval stamp of Underwriters and other authorities having jurisdiction of drawings requiring such approval.

7. Automatic temperature control system including diagrammatic layout of piping, wiring, control device, and equipment, and detailed descriptions of each item of equipment and its function in the system and system operation.

8. Refrigeration for field-assembled systems including description of specialties and pressure drops, layout of piping with lengths, fittings, and refrigerant specialties, and capacity curves for evaporator and compressor showing balance points.

E. Approval of shop drawings does not release Subcontractor from responsibility of coordinating his work at job site and taking field measurements. In cases where interferences become apparent, the Subcontractor shall notify Construction Coordinator so that such interferences may be resolved prior to proceeding with shop work. No claim will be allowed for work that might have to be moved or replaced based on a claim that work was placed in accordance with dimensions shown on an approved shop drawing.

1.09 RECORD DOCUMENTS

A. Record Drawings: Maintain a clean, undamaged set of blue or black line white prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date:

1. Mark new information that is important to the Construction Coordinator, but was not shown on Contract Drawings or Shop Drawings.

2. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

3. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.

4. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.

5. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

6. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

7. Contract Modifications, actual equipment and materials installed.

B. Mark Specifications to indicate approved substitutions and actual equipment and materials used.

1.10 MAINTENANCE MANUAL AND OPERATING INSTRUCTIONS

A. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy duty 2 in., 3 ring vinyl covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:

1. Spare parts list.

2. Copies of warranties.

3. Wiring diagrams.

4. Inspection procedures.

5. Shop Drawings and Product Data.

6. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

7. Manufacturer's printed operating procedures to include start up, break in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

8. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

9. Servicing instructions and lubrication charts and schedules.

B. At Substantial Completion, the Contractor shall provide the Owner with three (3) copies of a hardbound operating and maintenance manual for all equipment furnished and installed under his work.

C. Upon completion of the work, the Contractor shall put the systems into service. The Contractor shall be entirely responsible for the equipment during all testing operations.

1.11 WARRANTIES

A. Refer to Related Documents for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties specified in Division 15, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.12 PRODUCT LISTING

A. Prepare listing of major mechanical equipment and materials for the project.

B. When two (2) or more items of same material or equipment are required, they shall be by the same manufacturer. Product manufacturer uniformity does not apply as applicable for project to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.

C. Provide products which are compatible within systems and their connected items.

1.13 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Locate nameplates in an accessible and readable location.

1.14 COORDINATION OF WORK AND DRAWINGS

A. Each Contractor and subcontractor shall be responsible for coordinating the installation of his equipment and work with the work of other trades.

B. The layout shown on the Drawings is necessarily diagrammatic but shall be followed as closely as actual construction and as other work will permit. Changes from these Drawings required to make this work conform to the building construction or other work of other trades shall be made by the Contractor without additional cost to the Owner, but only with the prior approval of the Engineer. All major changes shall be shown on the Shop Drawings to be submitted before changes are made.

C. Each Contractor shall communicate and coordinate with all other contractors and subcontractors. Prior to fabrication and installation, prepare coordination drawings to a 1/4 in. equals 1 ft (1:48) scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. As a minimum, include the following information:

1. Planned piping layout, including valve and specialty locations and valve stem movement.

2. Planned duct systems layout, including elbow radii and duct accessories.

3. Placement of all equipment provided under Division 15.

4. Operating and maintenance clearances required by equipment manufacturers, including space for equipment disassembly required for periodic maintenance.

5. Clearances and access required by codes.

6. Clearances for installing and maintaining insulation.

7. Equipment service connections and support details.

8. Exterior wall and foundation penetrations.

9. Fire-rated wall and floor penetrations.

10. Sizes and location of required concrete pads and bases.

11. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

12. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

13. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

D. Layout shall be on shop drawings reflecting coordinated and integrated systems. Each shop drawing shall have a completed Contractor/ Subcontractor coordination log. These shop drawings shall be submitted to the Engineer for review. The Engineer will retain two (2) sets each. Provide one (1) paper copy and one compact disc electronic copy in AutoCAD, release 12 or later.

E. Any equipment, fixtures and/or material installed without the proper coordination shall be removed and reinstalled at the expense of that Contractor.

F. Each Contractor shall coordinate with the Test and Balance Contractor and shall provide the their respective work responsibilities noted in the Testing, Adjusting and Balancing Specifications

1.15 JOB CONDITIONS

A. Protection:

1. Protection of Work:

a. The Contractor shall protect his work from injury. Keep all pipes and lines capped or plugged, drained, or otherwise protected from injury, including damage done by flooding or stoppage from building materials or dirt.

b. The Contractor shall protect equipment and fixtures furnished under his contract from damage during the construction of the building and he shall provide all tarpaulins, drop cloths, barricades, temporary heaters, auxiliary pumping equipment or other precautions as may be required:

1) Any material or equipment that is damaged shall be removed immediately and replaced with new materials or equipment.

2. Damage to Building:

a. Any damage to the building or its contents incurred by the installation and/or testing of the systems installed under these contracts shall be repaired promptly.

3. Overloading of Building:

a. Care shall be taken that floors are not overloaded during building operations, and the Contractor shall promptly remove all materials, which may overload any part of the building.

4. Removal of Rubbish:

a. The Contractor shall at all times keep the premises free of all waste or surplus materials, rubbish and debris, which is caused by his employees or resulting from his work.

b. The Contractor shall provide drop cloths, or any other material necessary to protect floors, walls, furniture, equipment, etc., from soil or damage.

c. In case of dispute, the Owner may remove the rubbish, excess materials, or do all cleaning required and charge the cost to the Contractor.

1.16 WARRANTY

A. The warranty for all mechanical equipment (whether manufacturer's or contractor's warranty) shall comply with the requirements noted in the General Conditions. This equipment shall include all equipment provided under Division 15. Extended warranties shall be provided as specified under each section under Division 15.

1.17 RECORD DRAWINGS

A. A field set of Record Drawings shall be kept at the project site for review by the Engineer. These Record Drawings shall include notations of changes made, and shall be kept up to date at all times.

B. Engineer's approval of the mechanical portion of the pay request will be withheld if the above items have not been completed at the time of pay request review.

PART 2. PRODUCTS

2.01 MATERIALS

A. Materials and equipment shall be new, unless otherwise specified, and the best of their respective kinds.

2.02 SUBSTITUTIONS

A. Where an item of material or equipment is specified to be a certain manufacturer's make with other manufacturer's names specifically mentioned, the Base Bid proposal shall include material or equipment from one of those so specified.

B. Should the Contractor desire to receive consideration of equipment or materials other than as specified, he shall make such proposals in writing at the time of bidding, submitting therewith a statement of the extra or credit involved, if any, in the event the proposed substitution is accepted. Substitutes are not allowed in the base bid proposal consideration for substitutions will only be made in accord with Exhibit A criteria.

C. If a substitution is accepted by the Engineer, it shall be each Contractor's responsibility to ascertain that alternate manufacturer's products meet detailed specifications and that size and arrangement of equipment is suitable for installation.

D. If a substitution is accepted by the Engineer, it shall be the responsibility of each Contractor making a substitution to include any changes required by the other trades for a proper operation of the equipment substituted.

E. All proposed substitutions are subject to review by the Owner. Any substitutions which are accepted will be handled by a properly written Change Order after award of Contract and unless so set forth no proposed substitutions will be considered to have been accepted.

PART 3. EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contractor shall keep informed as to the Work of the trades engaged in the construction project, and other work being done in connection with the building, and shall execute his work in such a manner as not to interfere with or delay other Contractors.

B. The Contractor shall employ a competent foreman on the job throughout the entire period of construction to see that his work will not conflict with other work or trades, and that it is properly performed.

C. The foreman shall have a thorough knowledge of the work to be installed under this Contract and be a skilled mechanic experienced with projects of equal size and type.

D. Workmanship throughout shall correspond to the standard of best practice, and all labor employed must be competent and do the work required. Tool marks will not be permitted on any exposed materials, fittings or piping.

E. The Drawings accompanying these Specifications are design drawings and generally are diagrammatic. They do not show every offset, bend or elbow which may be required in the contract work for installation in the space allotted. The Contractor shall follow the Drawings as closely as practical and he shall install additional bends and offsets based upon measurements taken at the building, as may be required for installation of the work. Changes from these Drawings required to make this work conform to the Building construction work of other trades shall be made by this Contractor without additional cost to the Owner, but only with the prior written approval of the

Engineer. All major changes shall be shown on Shop Drawings to be submitted before the changes are made.

F. The Contractor will be expected to furnish materials and equipment promptly after award of contract, and shall proceed with his work without delay, and shall agree to perform and complete all of his work in progress with the work of other Contractors engaged on the project.

3.02 VISITING SITE

A. The Contractors shall visit the site and carefully examine the premises and thoroughly familiarize themselves as to the nature and scope of work and the difficulties that attend its execution.

B. The submission of a Proposal will be construed as evidence that such an examination has been made and later claims for labor, equipment or material required, or of difficulties encountered will not be recognized.

3.03 MEASUREMENTS

A. Contractors shall take their own measurements at the beginning and shall be responsible for the correctness of and proper fitting of their work.

B. Adjust all work to fit actual job conditions. Report to the Engineer all measurement discrepancies, so that field corrections can be made before fabrication of project components.

END OF SECTION 15010

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1. GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Plumbing Work:

a. Supports and anchorages.

b. Grout.

c. Motors and drives for equipment supplied under Plumbing Work.

2. Ventilating Work:

a. Supports and anchorages.

b. Grout.

c. Motor and drives for equipment supplied under Ventilating Work.

1.02 RELATED WORK

A. Specified Elsewhere:

1. Division 15 – All Sections.

1.03 SUBMITTALS

A. Submit each item in this Article in accordance with the conditions of the Contract.

B. Submit in accordance with 15010.

C. Product Data:

1. All Items Specified Herein.

2. Shop Drawings:

3. Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

D. Coordination Drawings:

1. Indicate access panel and door locations for all equipment and devices which require access.

1.04 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME B31.9:

1. Comply with provisions of ASME B31.9.

2. Certify that each welder has passed standard either ASME or AWS qualification tests for welding processes that each welder will perform and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements. The cost of such changes shall be the responsibility of the work section making the change.

PART 2. products

2.01 MOTORS AND DRIVES

A. Motors shall be standard NEMA design, of size and characteristics indicated on the Drawings and as follows:

1. Arranged to operate continuously under full load in an ambient temperature of 40°C.

2. Motor service factor not less than 1.15, determined by the specific application.

3. Drip-proof unless specific application requires a hermetic, totally enclosed or explosion proof motor as noted.

4. Provided with either internal or external thermal overload protection. Motors to be used with variable frequency controllers shall have internal thermal overload protection.

5. Permanently lubricated or grease reservoir type bearings. Reservoir type bearings shall have top and bottom screw plugs for flushing and repacking.

6. For convenient access (particularly to clear belt guards) the lubrication fittings shall be extended with pipe and fittings properly secured in place.

B. Windings shall be copper.

C. The following Table indicates minimum efficiencies and power factors for three phase enclosed motors operating fully loaded at 1,800 rpm with electrical characteristics of 200, 230, 460-Volts, 60 hertz. For open motors and motors running at speeds other than 1,800 rpm refer to the latest ASHRAE Standard 90.1 regarding minimum nominal motor efficiency table.

Horsepower	Efficiency	Power Factor
1	82.5	84
1-1/2	84.0	85.7
2	84.0	85.7
3	87.5	85.0
5	87.5	88.0
7-1/2	89.5	81.0
10	89.5	85.5
15	91.0	84.5
20	91.0	86.0
25	92.4	84.0
30	92.4	88.5
40	93.0	83.0
50	93.0	85.5
60	93.6	88.0
75	94.1	88.0
100	94.1	83.8
125	94.5	86.0
150	95.0	85.0
200	95.0	85.0

1. Approved Manufacturers and Models: Subject to compliance with the above specified requirements:

    a. General Electric.

    b. Lincoln.

    c. Reliance.

    d. Gould.

    e. Siemens.

    f. Louis-Allis.

    g. Baldor.

    h. Peerless.

    i. Century.

D. Drives shall have the following features:

1. Belted motors shall have sliding bases for adjustment of belt tension.

2. Equipped with sheaves of the vari-pitch type, except for equipment used with variable speed controllers. Drives and driven sheaves shall be machined cast steel.

3. Belt drives shall be of the V-belt type with drive capacity of at least 150 percent of motor horsepower. Belts shall be matched sets when multiple belt drives are used. No fan of integral HP or greater shall have less than two (2) belts.

4. Belt drives, shafts and couplings shall be fully guarded with heavily reinforced expanded metal or woven wire in accordance with OSHA and National Safety Council Standards.

5. Provide openings in the guards opposite all shafts to permit the use of a tachometer.

2.02 MOTOR STARTERS

A. Starters shall be provided under Division 16 for all motors provided under Division 15 unless specified otherwise.

B. Starters required to be provided under Division 15 shall be as specified in Division 16, Section 16480.

2.03 NON-SHRINK, NON-METALLIC GROUT

A. No Shrinkage, ASTM C-827.

B. Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.

C. Contain no expansive cements or metallic fillings.

D. Design mix – 5,000 PSI, twenty-eight (28) day compressive strength.

E. Pre-mixed and factory packaged.

F. Approved Manufacturers and Models: Subject to compliance with the above specified requirements:

1. Five Star Grout.

2. Master Builders - Master Flow 713.

3. W.R. Meadows - Field Tite 588 Non-Metallic.

2.04 ELECTRIC UNIT HEATERS

A. The electric horizontal heater(s) shall be as manufactured by Reznor, or approved manufacturer. Heater(s) shall be fully UL and C-UL approved, designed for either wall or ceiling mounting without modification, and be of KW capacity as shown on plans or schedules.

B. HOUSING: The cabinet shall be of heavy gauge, cold-rolled steel, welded and phosphatized, then finished with an epoxy paint. Removable to panels to gain full access to element, motor and fan area. Adjustable louvers shall be permanently attached and shall provide the desired directional control of air flow.

C. WIRING: All heater and control wiring connections shall terminate in the control box. Proper wiring diagram shall be attached to the inside of the control box. 75˚C wire must be used to enter the wiring compartment.

D. CONTACTORS: All heaters shall have a built-in, heavy duty, 3-pole contactor providing quiet, efficient operation, making external contacts and additional wiring unnecessary.

E. FAN MOTOR: Fan motor and controls shall be built into the unit to provide proper fan motor and control operation.

F. FAN DELAY: Fan control shall be bimetallic snap-action, and shall activate fan after heating element reaches operating temperature and continue to operate fan after the thermostat is satisfied until the heating element is cool.

G. THERMAL CUTOUT: Thermal cutout shall be attached directly to each bank of elements to shut off the heater in the event of overheating and reactivate the heater when temperature returns to normal.

PART 3. EXECUTION

3.01 ELECTRICAL WIRING

A. Contractor furnishing mechanical equipment shall provide all low voltage and line voltage control circuit wiring, conduit and connections and all wiring associated with starter holding coils, unless specifically designated as another contractor's work.

B. All wiring shall be in compliance with codes and Division 16 Specifications.

C. Electrical Contractor shall be responsible for all line voltage power wiring and final connections to complete the mechanical systems.

D. Electrical Contractor shall provide power circuit wiring and conduit to mechanical equipment components such as magnetic motor starters, manual motor starters, controller panels, disconnect switches, and motor starter heating elements.

E. Electrical Contractor shall provide all magnetic motor starters for Division 15 equipment unless specified otherwise.

F. The sharing of space within a common conduit by line voltage conductors and by control circuit conductors shall not be permitted.

G. In instances involving single phase motors or electrical devices controlled by another device, such as line voltage aqua stat or other line voltage controller, the respective equipment supplying Contractor shall provide the wiring and conduit between the controller and controlled device. The respective equipment supplying contractor shall connect the switched legs to the power wiring in a junction box located at the controlled device. The Electrical Contractor will provide the junction box and the power wiring between the power source and the controlled device.

3.02 ACCESS DOORS

A. Comply with manufacturer’s instructions for installing access doors.

B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finished surfaces. Install concealed-frame access doors flush with adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

D. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

E. Door shall be properly prepped, primed and painted to match wall or ceiling.

F. Access doors for plumbing chase walls shall be mounted 16” above the finished floor, and shall be 2’ – 0” x 2’ – 0” unless otherwise noted.

3.03 PAINTING

A. Where factory finishes are provided on equipment, and no additional field painting is specified, all marred or damaged surfaces shall be touched-up or refinished by the Contractor furnishing the equipment, so as to leave a smooth, uniform finish at the time of final inspection. Where steel equipment has been scratched as to expose the metal, a prime coat of rust-inhibitive primer shall be applied prior to final touch-up or refinishing.

B. All structural steel or other ferrous metal installed furnished by any Contractor which is not galvanized, either inside or outside of the building shall be cleaned of all grease, oil, dirt, loose scale, etc. and given a prime coat of rust-inhibitive primer at the time of installation. All exposed structural steel or other ferrous metal installed outdoors and is not galvanized or specified to be painted with the Painting Section of the specifications shall be painted with two additional coats of long oil type paint with rust and corrosion-resistant qualities, under the work that is installs the structural steel or ferrous metal.

C. Equipment and structural steel, except where provided with a factory finish, shall be painted machine gray. Nameplates are to be left unpainted.

3.04 EQUIPMENT AND MATERIAL PROTECTION

A. Receiving and Preparation of Equipment:

1. Subcontractor shall receive, unload, inspect and store all equipment and materials, whether furnished by the Subcontractor or furnished by others.
2. Subcontractor shall examine and inspect equipment and material upon receipt for shortages or damage. Subcontractor shall conduct any testing as required to establish the condition of the equipment upon receipt.
3. Unless a deficiency report is submitted in writing by the Subcontractor to the Fermilab Construction Coordinator, all equipment and materials are assumed to be received in good condition, complete with all parts and components.
4. Subcontractor shall carefully close, repair, and restore shipping crates and boxes so as to maintain the equipment in clean, and like new condition, and to avoid loss of parts during storage.

5. Subcontractor shall carefully review installation/operations manuals and other instructions regarding protection of their equipment during storage and before operations.

B. Handling and Storage:

1. After equipment has been received and moved into the designated storage area, Subcontractor shall unpack each individual carton, and visually inspect and check for correct and complete installation of all parts, components, equipment, and associated devices in accordance with the manufacturer's drawings. Protective packaging shall then be re-installed following inspection and shall not be removed until the equipment is ready to be installed into its permanent location.

2. Subcontractor shall be responsible for storage and protection of equipment and materials from the time of receipt until final installation and acceptance of the Fermilab Construction Coordinator.

3. The type of storage and protection shall be determined from the manufacturer's instructions and specific instructions from Fermilab Construction Coordinator.

4. Maintenance requirements at the storage areas shall include the following:

   a. Access shall be controlled.

   b. Condition of the storage area shall be monitored so that lack of protection, such as loss of heat or weatherproof covering, is detected and corrected.

   c. Fire protection shall be compatible with materials stored and type of storage.

   d. Sources of contamination, such as rodents, flooding, and eating and drinking in areas, shall be controlled.

5. Storage areas shall be organized to maintain proper segregation and retrievability of material.

END OF SECTION 15050

SECTION 15060 - PIPE AND PIPE FITTINGS

PART 1. GENERAL

1.01 WORK INCLUDES

A. Base Bid:

1. Plumbing and Ventilation Work:

a. Provide and install pipe and fittings as indicated including all offsets, fittings, sleeves, and accessories required for a complete and operable system.

b. Provide pipe supports as required.

c. Provide ceiling, wall, and floor plates as required

1.02 RELATED WORK:

A. Division 15 – All Sections.

1.03 SUBMITTALS

A. Product Data:

1. All Items Specified Herein.

1.04 QUALITY ASSURANCE

A. Furnish proof of the competency of each welding operator, for both field and shops welds, and have all welding operators pass a standard qualification test such as A.S.M.E. or A.W.S. procedure and tests.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE AND FITTINGS

A. The type and class of pipe, fittings, coating, lining and joints to be used for each function and location is specified in pipe schedules or references in other Sections or on Drawings.

B. Steel Pipe: ASTM A-106 or ASTM A-53 Grade B:

1. Schedule 40 unless noted or specified otherwise.

2. Uncoated black pipe unless specifically designated hot dip galvanized.

3. Fittings:

a. N.P.T. screw joints. (1/4” to 2”):

1) Banded malleable iron, 150 pounds per square inch standard weight; ANSI B16.3; hot dip galvanized where specifically designated.

2) Cast iron, 125 pounds per square inch standard weight; ANSI B16.4; hot dip galvanized where specifically designated.

3) Cast iron, 250 pounds per square inch heavy weight; ANSI B16.4; hot dip galvanized where specifically designated.

4) Unless specified otherwise, all screwed joints shall be cast iron, 125 pound per square inch.

b. Welded Joints (2-1/2” and up):

1) Butt welding fittings, ASTM A-234 and ANSI B16.9.

2) Wall thickness and weight schedules: ANSI B36.10.

3) Ends: Single vee beveled butt type, ANSI B16.25.

c. Flanged Joints (2-1/2” and up):

1) Steel pipe flanges, ANSI B16.5.

2) Gasket fluorocarbon elastomer.

4. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Copper tube and fittings:

1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).

2. Wrought-Copper Unions: ASME B16.22.

3. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

4. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

D. Dielectric fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Matco-Norca.

4) Watts Regulator Co.

5) Zurn Industries, LLC.

b. Description:

1) Standard: ASSE 1079.

2) Factory-fabricated, bolted, companion-flange assembly.

3) Pressure Rating: 125 psig (860 kPa) minimum at 180°F (82°C).

4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Advance Products & Systems, Inc.

        2) Calpico, Inc.

        3) Central Plastics Company.

        4) Pipeline Seal and Insulator, Inc.

    b. Description:

        1) Non-conducting materials for field assembly of companion flanges.

        2) Pressure Rating: 150 psig (1035 kPa).

        3) Gasket: Neoprene or phenolic.

        4) Bolt Sleeves: Phenolic or polyethylene.

        5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Elster Perfection.

        2) Grinnell Mechanical Products.

        3) Matco-Norca.

        4) Precision Plumbing Products, Inc.

        5) Victaulic Company.

    b. Description:

        1) Standard: IAPMO PS 66.

        2) Electroplated steel nipple, complying with ASTM F 1545.

3) Pressure Rating: 300 psig (2070 kPa) at 225°F (107°C).

4) End Connections: Male threaded or grooved.

5) Lining: Inert and noncorrosive, propylene.

5. Y-Pattern Strainers:

a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.

c. Strainer Screen: Stainless-steel, 40-mesh start up strainer and perforated stainless-steel basket with 50 percent free area.

d. CWP Rating: 125 psig (860 kPa).

2.03 PIPE SUPPORTS

A. Suspension Hangers:

1. Adjustable wrought steel clevis type.

2. Copper plated for all hangers in direct contact with copper lines.

	2-1/2 In. IPS and Smaller	3 In. IPS and Greater	Copper/Brass Piping, All Sizes
Grinnell	Fig. 65	Fig. 260	Fig. CT 65
B-Line	Fig. 3104	Fig. 3100	Fig. 3104 CT
Persing	Fig. 230	Fig. 200	Fig. 220 CT

3. Adjustable steel yoke pipe roll:

a. Grinnell - Fig. 171/181.

b. B-Line - Fig. B3110/B3114.

c. Persing - Fig. 322/324.

4. Pipe Covering Protection Sleeves for Insulated Pipe:

a. Grinnell - Fig. 167 Series.

b. B-Line - Fig. 35L Series.

c. Persing - Fig. 400 Series.

5. Pipe Covering Protection Saddles For Insulated Pipe:

a. Grinnell - Fig. 160 Series.

b. B-Line - Fig. 3160 Series.

c. Persing - Fig. 400 Series.

6. Pipe Protection/Thermal Insulation Hanger Shields for Insulated Pipe:

a. B-Line - Fig. B3195 Series.

b. Insul-shield.

c. Pipe Shields.

d. Uni-grip.

7. Hanger Rods:

a. ASTM A36.

b. Hanger rod sizes:

Pipe Size	Hanger Rod Diameter
2” and smaller	3/8”
2-1/2” to 3-1/2”	1/2”
4” to 5”	5/8”
6”	3/4”
8”	7/8”
Over 8”	As per Hanger Manufacturer Recommendations

B. Wall Brackets:

1. Welded steel with capacity as required:

a. Grinnell - Fig. 194/195/196/Clip Fig. 193.

b. B-Line - Fig. B3063/B3068/B3067/Clip Fig. B3063 CP.

c. Persing - Fig. 153/151/153/Clip Fig. 153 C.

C. Galvanized Pipe Rollers.

D. Preformed Metal Framing Channels:

1. Continuous slotted steel framing channel in gauge and size for capacities required complete with the matching fittings, nuts, bolts and hangers as shown on the drawings.

2. Approved Manufacturers and Models: Subject to compliance with the above specified requirements:

a. Unistrut.

b. Superstrut.

c. B-Line.

2.04 CEILING, WALL AND FLOOR PLATES (Escutcheons)

A. Pipe Penetrations:

1. Hinged snap-on style.

2. 3/4” IPS and Smaller, Chromium plated brass.

3. 1” IPS and Larger, Chrome Plated Steel.

4. Sized to fit snugly around uncovered pipe, pipe covering, or sleeve extensions as each location necessitates.

B. Hanger Rod Entrance, Finished Room Ceilings:

1. Spring ceiling plates.

2. Chrome plated brass.

2.05 Glycol

A. Propylene Glycol: Industrial grade glycol specifically designed for used in HVAC systems, with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. HOH Pro-Kool 38.

PART 3. EXECUTION

3.01 PIPING SERVICE SCHEDULE

A. Piping shall be provided as follows:

SERVICE	MATERIAL
1. Plumbing Piping	See applicable plumbing sections
2. Natural Gas	Black Steel, Sched. 40
3. Chilled Water – 2" and smaller	Drawn temper copper tubing with wrought copper fittings Or Black Steel, Sched. 40 with threaded joints
4. Chilled Water – 2-1/2" and larger, Industrial Water (ICW)	Black Steel, Sched. 40 with welded joints
5. Underground Piping	See applicable Civil sections

3.02 ELEVATIONS, GRADES AND LINES

A. Contractor's Responsibility:

1. See Section 01051.

B. Pipe Bury:

1. Where definite grades, elevations or profiles are not indicated on the Drawings, install pipelines at the following depths, top outside center pipe to finish ground surface:

Fluid in Pipe	Minimum Earth Cover
Storm	3' – 6"
Sanitary	3' – 6"
Gas	1' – 6"
Sump Pump Discharge	3' – 6"
Water (DWS)	5' – 0"
Industrial Water (ICW)	5' – 6"

3.03 EXCAVATING AND BACKFILLING

A. Contractor's Responsibility:

1. Each Contractor performing work of any category is responsible for the excavation and backfilling necessary for installation of his work.

2. Perform excavation of every character of sub-surface material encountered, including frangible rock, solid rock, rubble, existing foundations, footings, bases, fluid sand, and muck. The nature of material excavated is not cause for charge in lump sum price.

3. Provide sheathing and bracing as required for protection of workmen, for protection of work installed in the excavation and for compliance with regulatory agency rules.

4. Remove and dispose of surplus excavated material, away from the premises, in a manner that conforms with local regulations. Any surplus earth or materials not removed promptly by the Contractor will be removed by others as directed by the Owner and the cost of the removal charged to the Contractor.

B. General:

1. Excavation and backfilling in streets and parkways shall be in accordance with the requirements of the City or governing body having jurisdiction.

2. Excavations are to be conducted that no walls or footings are disturbed or injured and with a minimum of disturbances to the subgrade.

3. No power trenching equipment will be permitted inside the building lines, except upon written permission of the Engineer.

4. Maintain all trenches and excavations free of standing water. Provide all pumping equipment, labor and energy for operating same.

5. Divert dewatering apparatus discharge to natural drainage courses, curbs or storm sewers, not to sanitary sewers.

6. Fill materials, fill placement and compaction procedures are subject to the approval of the Engineer.

7. If cinder fill is unexpectedly encountered, notify the Engineer. All pipe and conduits installed in cinder fill shall be encased in 6" thickness of 3,000 PSI, normal weight concrete.

8. No piping or other work shall be covered until inspected, tested and reviewed by the Engineer.

C. Pipeline trenches below concrete slabs on grade or paved area:

1. Excavate 4” deeper than planned outside bottom center of pipe.

2. Place a layer of bank sand, or approved equivalent, 4” nominal thickness, between trench bottom and pipe to act as uniform support pad and spacer.

3. Fill around and over installed pipe with compacted sand or other approved granular material to underside of concrete slab or base course.

4. Backfill material shall be placed in successive 8” thick layers and each layer compacted by pneumatic or mechanical tampers to 90 percent of maximum dry density as established by Modified Proctor Test (ASTM D-1557) for cohesionless soils and 90 percent for cohesive soils.

D. Pipeline trenches through unpaved areas:

1. Provide pipe bedding and backfill material as specified in preceding subparagraph, except that backfill shall terminate 9” from the top of the trench excavation.

2. The top 9” of the excavation shall be restored with a material type to match the existing materials.

3. In the case of trenching through natural earth or previously backfilled areas, the backfill shall be compacted and mounded 6” above existing grade to allow for settlement.

3.04 SUPPORT OF UNDERGROUND PIPING

A. Where fill or loose soil of shallow depth is encountered, over-excavate down to firm undisturbed earth and backfill to the proper elevation with bank sand or crushed stone compacted to provide a firm support for the pipelines.

B. Where deep fill or large areas of unstable soil is encountered, support the pipe at least every 10’ – 0” (at each hub of cast iron soil pipe and cast iron water pipe) on concrete piers or concrete blocks with footings set on undisturbed earth, and fill the area between the piers with firmly compacted granular material.

C. At the foot of each plumbing riser, provide a concrete foundation with base set on solid earth for support of the stack.

D. Set all equipment bases, basins, and similar structures on solid undisturbed earth and provide substantial bases:

1. Where loose fill or unstable soil is encountered, provide concrete foundations, properly reinforced and carried down to firm bearing with footings set on undisturbed earth.

2. Design and construction of all bases and foundations must be reviewed by the Engineer.

3.05 CUTTING, DRILLING, AND PATCHING

E. Each Contractor shall do all cutting and drilling that is required in order that its work may be properly installed and it shall do all patching and repairing required to restore all surfaces to their original condition.

F. Where holes are required, these shall be cut in a careful manner and the openings kept to an absolute minimum.

G. The cutting and drilling into structural members or slabs may be accomplished only upon the prior written concurrence of the Engineer.

H. Openings in a slab on grade shall be made by scoring with a concrete saw followed by a chiseled clean break. Such floor openings shall be restored using fully compacted granular subgrade and concrete bonded to the vertical pipe installed through the floor. No sleeve is to be placed in such case and concrete shall be sloped upward around the pipe to prevent water ponding at that point.

I. All patching and repairing shall be done by experienced men in the particular trades to which the respective kinds of work belong; and shall be neatly made, restoring the area to its original condition to the satisfaction of the Engineer.

3.06 FLOOR AND WALL PENETRATIONS

A. Provide noncombustible seals around pipe and duct penetrations for both new and existing construction at:

1. All Floors.

2. Exterior Walls.

3. Below-Grade Walls.

4. Two (2) Hour and Greater Fire Rated Walls.

5. Smoke Partition Walls.

6. Where Designated by Code.

B. Noncombustible pipe penetrations shall consist of:

1. Pipe sleeves.

2. Fireproof fill in annular space.

3. Surface sealing compound.

4. Provide pipe sleeves for the following:

   a. All new construction.

   b. Existing construction except where a smooth core drilled hole may be obtained.

5. Pipe Sleeve Material:

   a. Concrete construction.

   b. Steel pipe sleeve with square welded steel plate extending no less than 6” beyond sleeve, all rustproofed.

   c. Masonry Construction.

   d. Galvanized Steel Pipe.

   e. Wallboard or Plaster Construction.

   f. 26 gauge galvanized steel.

6. Pipe Sleeve or Core Drill Size:

   a. Diameter great enough to leave 1/2” clearance all around:

      1) Pipe not to be covered.

      2) Covering of insulated pipe.

7. Pipe Sleeve Length:

   a. Length to suit wall or floor thickness:

      1) In walls, ends flush with each wall face.

      2) Underside of floors, extend downward approximately 1” below bottom of floor surface.

      3) Above floors, extend upward approximately 3” above finished floor surface.

8. Annular Space Filler For Pipes:

a. Below-Grade Exterior Walls:

1) Mechanical seals consisting of synthetic rubber links with plated steel bolts and Delrin pressure plates that provide hydrostatic sealing.

b. All Other Walls and Floors:

1) Fire rated caulking compound designed expressly for this purpose.

2) Mechanical seals described above.

c. Approved Manufacturers and Models: Subject to compliance with the above specified requirements:

1) Cherne Ind. - Gripper 1” – 8”

2) Thunderline - Link Seal.

3) Instafoam - Front Pak.

C. All Other Wall Pipe Penetrations:

1. Pipe Penetrations consist of:

a. Finished and unfinished space: Pipe sleeve as described in noncombustible pipe penetrations.

b. 1/2” annular space between pipe and wall.

3.07 GENERAL ARRANGEMENT OF PIPING SYSTEMS

A. All piping shall be run as directly as possible straight and plumb, at uniform grades, so that the systems may be properly drained.

B. All piping shall be run at right angles, or parallel to walls. Offsets shall be made by means of proper fittings. The use of bent pipe will not be accepted.

C. Do not run piping through transformer vaults, elevator equipment rooms or other electrical or electronic equipment spaces and enclosures. Do not run piping over electrical panels.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe for hydronic piping and top of main pipe for gas piping. For up-feed risers, connect the branch to the top of the main pipe.

N. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

O. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

P. Install shutoff valve immediately upstream of each dielectric fitting.

Q. Comply with requirements in Section 15077 “Identification for HVAC Piping and Equipment” for identifying piping.

R. Install manual vents at high points of the hydronic systems where air may become trapped. Extend bleed tubing down near floor.

3.08 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.

C. Dielectric Fittings for NPS 2-1/2 (DN 65) and larger: Use dielectric flanges or flange kits.

3.09 EXPANSION AND CONTRACTION OF PIPE

A. Provide allowances for expansion and contraction of installed piping. Install piping in a manner that will not cause more than negligible stress nor cause leaks due to thermal expansion and contraction. Movement of pipe shall not result in noise generation.

B. Do not use slip type expansion joints on pipelines within the building.

3.10 PIPE JOINTING

A. Cleaning:

1. Care shall be taken to keep pipe compound and all other foreign matter from entering the interior of the piping. Each section of pipe and all fittings shall be carefully inspected for dirt, grease, or other foreign matter on the inside. They shall be properly cleaned before assembly.

2. Thoroughly clean the piping systems after completion to the satisfaction of the Engineer.

B. Threaded Pipe:

1. Threads shall be full and clean cut, and ends of pipe shall be reamed.

2. When screwed joints are assembled, the male thread shall be thoroughly coated with jointing compound to serve as a joint sealer and as a primer for the exposed threads.

3. Approved joint sealer Manufacturers and Models: Subject to compliance with the above specified requirements:

a. Loctite PST565 for sizes up to 2” NPT.

b. Loctite PST564 for sizes greater than 2” NPT.

C. Copper Tubing Joints:

1. Soldered Joints:

a. Solder: 95-5 on all lines except refrigerant lines; silver solder on refrigerant lines.

b. Clean mating surfaces of tube and fitting to bright sheen and apply flux.

c. Apply solder and heat until the molten solder is drawn into the joint by capillary action and the connection is tight.

2. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

3.11 SUPPORT OF INTERIOR PIPING

A. All piping shall be supported as specified herein. All structural steel, hanger rods, turnbuckles, beam clamps, angle iron clips, inserts, brackets, floor bases, supports and bracing shall be provided.

B. Horizontal suspended piping shall be supported with adjustable hanger assemblies. Provide the specified clevis type with weight bearing insulation and protection shield. All hanger rods shall have enough length and threaded length to allow adjustment.

C. Perforated strap iron hangers, band iron, or wire will not be accepted.

D. Spacing of hangers or other supports:

	Maximum Spacing		
Pipe Sizes	Ferrous Pipe	Copper Tub-ing	Polypropylene, PVC Pipe
1/2" – 1"	6'	5'	6'
1-1/4" – 2"	9'	8'	9'
2-1/2" – 3-1/2"	12'	8'	10'
4" – 6"	14'	8'	10'
8" – 14"	20'		10'
Over 14"	As per Pipe Manufacturers Recommendations		

E. Horizontal pipe with compression or clamp joints shall be supported by an approved hanger not less than 18" from the joint. See Paragraph "Pipe Supports" this Section.

F. Securely fasten hanger supports to structural members by approved beam clamps and clips, concrete inserts, anchors, or other appropriate methods reviewed by the Engineer. Locate concrete inserts or anchors to miss rebars. Do not locate inserts or anchors closer than 6" apart.

G. Use bracket type hanger fastened to walls to support piping running adjacent to walls and not supported from ceilings.

H. Pipe hangers must be cleaned and painted with rust resistant paint before installation.

I. Where necessary to secure piping so as to control direction of expansion, provide welded type pipe anchors of design as will meet with the satisfaction of the Engineer, securely attached to the building construction and welded to the pipe.

J. Protection saddles shall not be used on insulated piping with vapor barriers. Continuity of vapor barrier shall be maintained at all joints, connections, hangers and shield.

3.12 WELDING

A. Welded pipe joints shall be made by the oxy-acetylene or electric process in accordance with ASME B31.9 (current issue).

B. Welding shall be done with good quality modern welding equipment, by competent operators, and in thorough, first class manner, conforming to ASME B31.9.

C. Furnish proof of the competency of each welding operator for both field and shop welds. All welding operators shall pass a standard qualification test such as A.S.M.E. or A.W.S.

D. Filler-metal for the welding process shall conform to ASTM A233 “Specification for Mild Steel Arc-Welding Electrodes.” Classification of electrodes shall be one of the following: E6010, E6015, E7016, E7018.

E. When welding will be performed, precautionary measures shall be taken to prevent fire. Remove flammable materials and debris from the area. Provide an appropriate extinguisher nearby.

F. Pipes shall be cut short and cold sprung into place before welding or fabricating to compensate for expansion of lines when hot.

G. Welds shall be of the single vee butt type. Pipe ends shall be shop beveled to 45° to within 1/16” of the inside wall surface.

H. The abutting ends of the joints shall be separated before welding to permit complete fusion, tacked in two (2) or more points to maintain alignment, and welded. Welding shall be continuous around the pipe.

I. Welds shall be of sound weld metal, thoroughly fused into the ends of the pipe and to the bottom of the vee, and shall be built up in excess of the pipe wall to give a reinforcement of one-quarter (1/4) the pipe wall thickness and in such a manner that one weld metal will present a gradual increase in thickness from the surface of the pipe to the center of the weld. The minimum width of the weld shall be two and one-half (2-1/2) times the pipe wall thickness.

J. The fillet welds from flanges of fittings shall be fused into the pipe and plate for a minimum distance of one and one-half (1-1/2) times the pipe wall thickness and shall be built up to present a minimum throat thickness of depth of weld of one and one-fourth (1-1/4) times the pipe wall thickness.

K. Branch connections shall be fabricated by welding. Openings cut into pipe for welded connections shall be accurately made to give carefully matched intersections and welding fittings shall be carefully welded into the pipe system.

L. Welding ells shall be used at all turns in welded pipe lines; no mitered ells will be approved.

M. Where welded mains are smaller than three times the branch diameter, branch connections shall be made with welded tees. Appropriate weld fittings shall be used for all other branch connections:

1. Approved Manufacturers and Models: (Weld Fittings) Subject to compliance with the above specified requirements:

a. Allied Piping Products.

b. Bonney Forge.

c. Branch Connections.

d. Branchlets.

e. Tube Turn.

f. Thread-O-Lets.

3.13 CLEANING THE PIPING SYSTEMS

A. Before pipe covering is applied and final tests are made, flush out the piping systems thoroughly to remove dirt, sand, oil and other deleterious substances, for sufficient time to thoroughly clean the apparatus and piping. Make the temporary connections for this purpose.

B. Take care not to get dirt, grease, on the floors or walls. Damage done shall be repaired to the satisfaction of the Engineer.

C. After a period of operation, all defects or damages that may have developed in the equipment and apparatus as result of the cleaning out process shall be corrected to the satisfaction of the Engineer.

D. Special tubing/piping runs for transmission of various gases shall be cleaned as specified in Section 15480.

3.14 INSPECTION AND TESTING

A. All piping systems shall be tested for leaks and subject to Engineer's written approval before covering is applied and before backfilling or concealing within the structure.

B. Notify the Engineer three working days before the tests are to be made. Concealed work shall remain uncovered until specified tests have been completed; when necessary, tests on portions of the work may be made so that those portions of the work may be concealed after being proven satisfactory. All tests shall be made in the presence of the Engineer. Repairs or defects that are discovered as a result of inspection or tests shall be made with new materials. Caulking of screwed joints, cracks, or holes will not be accepted. Tests shall be repeated until all defects have been eliminated. Furnish the equipment, material, and labor to accomplish the tests.

C. A water pressure test shall be applied to all parts of the drainage systems, before the pipes are concealed or fixtures set in place. The test may be applied in sections. All openings of each system to be tested shall be tightly closed except the highest openings above the roof and the entire system or sub-system shall be filled with water up to the overflow point of this highest opening. All parts of the system shall be subjected to not less than 10 ft of hydrostatic head except the uppermost 10 ft of the piping directly below the opening. The water shall remain in the system for not less than thirty (30) minutes after which time any leaks at any joints or lowering of the water level at the overflow shall be visible.

D. Cap all open connections in the water piping systems and fill the sections of piping to be tested with water at 100 pounds per square inch gauge pressure registered at ground floor level. The system shall be carefully inspected and all defective material replaced and leaks repaired. The test pressure shall be held for a minimum period of one (1) hour without variation in pressure except that which is due to changes in temperature.

E. Cap up all open connections in the gas piping system. A suitable air chamber shall be attached to the system and dry compressed air or nitrogen introduced until a pressure of 125 pounds per square inch is reached. The system shall be isolated before the test begins. The test pressure shall be held for a minimum period of one (1) hour without variation in pressure except that which is due to changes in temperature.

F. Welding piping shall be subject to a hydrostatic test of not less than 100 pounds per square inch, or one and one-half (1-1/2) times the working pressure, whichever is the greater at which pressure all welded joints shall be hammered with a three pound hammer, the blows being struck with a sufficient force to jar the pipe and joint, but not so hard as to injure the piping. All welds shall pass this test without showing leaks or any defects.

G. All preliminary tests which the Contractor may make, without such tests being observed by the Engineer will not be accepted as meeting this Specification, irrespective of the alleged results.

END OF SECTION 15060

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.

2. Trapeze pipe hangers.

3. Thermal-hanger shield inserts.

4. Fastener systems.

5. Pipe positioning systems.

6. Equipment supports.

B. Related Sections:

1. Division 5 Section “Metal Fabrications” for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.02 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.

2. Metal framing systems.

3. Equipment supports.

C. Welding certificates.

1.05 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code - Steel.”

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2. PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper colored, epoxy-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2” (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.07 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.08 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3. EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4” (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 15 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

3. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180°.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

5. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12” (305 mm) long and 0.048” (1.22 mm) thick.

    b. NPS 4 (DN 100): 12” (305 mm) long and 0.06” (1.52 mm) thick.

    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18” (457 mm) long and 0.06” (1.52 mm) thick.

6. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2” (40 mm).

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports or metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566°C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4” (100 mm) of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4” (100 mm) of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

16. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.

17. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6” (150 mm) for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450°F (49 to 232°C) piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F (49 to 232° C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).

    b. Medium (MSS Type 32): 1500 lb (680 kg).

    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

2. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

3. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.

b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 15061

SECTION 15076 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.
6. Sample Schedules

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Photo Samples: For color, letter style, and graphic representation required for each identification material and device, provide a color photo or color brochure.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.03 QUALITY ASSURANCE

A. Follow manufacturer’s recommended installation procedures.

B. Comply with ASME A13.1 “Scheme for the Identification of Piping System” as applicable to the project.

1.04 DELIVERY, STORAGE AND HANDLING

A. Store materials in a dry and secure area on-site and protect against dirt and moisture damage

B. Do not apply or install damaged materials.

1.05 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Kolbi Manufacturing

2. Marking Services

3. Brady Corporation

2.02 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032” or Stainless steel, 0.025” minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2” by 3/4”.

3. Minimum Letter Size: 1/4” for name of units if viewing distance is less than 24”, 1/2” for viewing distances up to 72” and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel self-tapping screws.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2” by 11” bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data. See Sample Equipment Schedule at the end of this Specification.

2.03 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8” thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160°F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2” by 3/4”.

F. Minimum Letter Size: 1/4” for name of units if viewing distance is less than 24”, 1/2” for viewing distances up to 72”, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.04 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2” high.

2.05 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4” letters for piping system abbreviation and 1/2” numbers.

1. Tag Material: Brass, 0.032” or Stainless steel, 0.025” minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2” by 11” bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data. See Sample Valve Tag Schedule at the end of this Specification.

2.06 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 4” by 7”

2. Fasteners: Reinforced grommet and wire.

3. Nomenclature: Large-size primary caption such as “DANGER,” “CAUTION,” or “DO NOT OPERATE.”

4. Color: Yellow background with black lettering.

PART 3. EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 9 Section "Interior Painting"

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 25’ along each run. Reduce intervals to 15’ in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Domestic Water Piping:

a. Background Color: Blue.

b. Letter Color: White.

2. Domestic Hot Water Piping:

a. Background Color: Red.

b. Letter Color: White

3. Sanitary Waste and Drainage Piping:

a. Background Color: Black.

b. Letter Color: White.

4. Storm and Overflow Storm Piping:

a. Background Color: Green.

b. Letter Color: White.

3.04 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule. See Sample Valve Tag Schedule at the end of this Specification.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 2” round.

b. Hot Water: 2” round.

2. Valve-Tag Color:

a. Cold Water: Natural.

b. Hot Water: Natural.

3. Letter Color:

a. Cold Water: Black.

b. Hot Water: Black.

3.05 WARNING TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.06 SAMPLE SCHEDULES

A. The following tables are examples of schedules required to be submitted by the Contractor. Examples of the kinds of information to be included are in the first row in these tables.

DOMESTIC COLD WATER, VALVE-TAG SCHEDULE

VALVE NUMBER	VALVE TYPE	VALVE SIZE	VALVE LOCATION	NORMAL OPERATING POSITION	REMARKS
CWS-1	GATE	NPS 2	MECHANICAL ROOM M-1	OPEN	

EQUIPMENT LABEL SCHEDULE

EQUIPMENT IDENTIFICATION	EQUIPMENT LOCATION	SPECIFICATION SECTION		REMARKS
		NUMBER	TITLE	
DWBP-1	MECHANICAL ROOM M-215	15xxx		DOMESTIC WATER BOOSTER PUMP

3.07 CLEANING

A. Follow manufacturer’s installation instructions for surface preparation prior to application or installation.

B. Follow Manufacturer’s instructions for cleaning labels and tags.

END OF SECTION 15076

SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1. GENERAL

1.01 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.
7. Sample Schedules.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label. An electronic copy and hard copy will be provided to OWNER before preliminary acceptance. Furnish extra copies (in addition to mounted copies) for Maintenance.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals. An electronic copy and hard copy will be provided to OWNER before preliminary acceptance. Furnish extra copies (in addition to mounted copies) for Maintenance.

1.03 QUALITY ASSURANCE

A. Follow manufacturer's recommended installation procedures.

B. As applicable, comply with ASME A13.1 "Scheme for the Identification of Piping System"

1.04 DELIVERY, STORAGE AND HANDLING

A. Store materials in a dry and secure area on-site and protect against dirt and moisture damage

B. Do not apply or install damaged materials.

1.05 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.06 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Seton
2. Brady
3. Best
4. Milwaukee

2.02 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032” or Stainless steel, 0.025” minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Letter Size: 4” by 2”. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Fasteners: Stainless-steel self-tapping screws.
4. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2” by 11” bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data. See Sample Equipment Schedule at end of this Specification.

2.03 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8” thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160°F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2” by 3/4”.

F. Minimum Letter Size: 1/4” for name of units if viewing distance is less than 24”, 1/2” for viewing distances up to 72” and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions. Coordinate with Architect and Owner for specific warning label information to be included.

2.04 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. Do not provide labels for bare pipes conveying fluids at temperatures of 125°F or higher.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2” high.

2.05 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8” thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160° F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2” by 3/4”.

F. Minimum Letter Size: 1/4” for name of units if viewing distance is less than 24 inches, 1/2” for viewing distances up to 72” and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2” high.

2.06 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4” letters for piping system abbreviation and 1/2”numbers.

1. Tag Material: Brass, 0.032” or Stainless steel, 0.025” minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2” by-11” bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data. See Sample Valve Tag Schedule at the end of this Specification.

2.07 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 4” by 7”.

2. Fasteners: Reinforced grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3. EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 9 Section “Interior Painting”

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 25’ along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping:

a. Background Color: Blue.

b. Letter Color: Black.

2. Condenser-Water Piping:

a. Background Color: Blue.

b. Letter Color: Black.

3. Heating Water Piping:

a. Background Color: Red.

b. Letter Color: Black.

4. Refrigerant Piping:

   a. Background Color: White.

   b. Letter Color: Black.

5. Low-Pressure Steam Piping:

   a. Background Color: White.

   b. Letter Color: Black.

6. Steam Condensate Piping:

   a. Background Color: White.

   b. Letter Color: Black

7. Industrial Water Piping:

   a. Background Color: Yellow.

   b. Letter Color: Black

3.04 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

   1. Blue: For supply ducts.

   2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50’ in each space where ducts are exposed or concealed by removable ceiling system.

3.05 VALVE-TAG INSTALLATION

A. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

   1. Valve-Tag Size and Shape:

      a. Chilled Water: 2”, round.

      b. Condenser Water: 2”, round.

      c. Refrigerant: 2”, round.

d. Hot Water: 2”, round.

e. Gas: 2”, round.

f. Low-Pressure Steam: 2”, round.

g. Steam Condensate: 2”, round.

h. Industrial Water: 2”, round

2. Valve-Tag Color:

a. Chilled Water: Natural.

b. Condenser Water: Natural.

c. Refrigerant: Natural.

d. Hot Water: Natural.

e. Gas: Natural.

f. Low-Pressure Steam: Natural

g. Steam Condensate: Natural

h. Industrial Water: 2”, round

3. Letter Color:

a. Chilled Water: Black.

b. Condenser Water: Black.

c. Refrigerant: Black.

d. Hot Water: Black.

e. Gas: Black.

f. Low-Pressure Steam: Black.

g. Steam Condensate: Black.

h. Industrial Water: 2”, round

3.06 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.07 CLEANING

A. Follow manufacturer's instructions for surface preparation prior to application or installation.

B. Follow Manufacturer's instructions for cleaning labels and tags.

END OF SECTION 15077

SECTION 15083 - HVAC INSULATION

PART 1. GENERAL

1.01 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100°F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75°F.

D. Thermal Resistivity: “R-values” represent the reciprocal of thermal conductivity (K-value). Thermal conductivity is the rate of heat flow through a homogeneous material exactly 1” thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.

E. Density: Is expressed in lb./cu.ft.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thermal resistivity (R-value), thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail attachment and covering of heat tracing inside insulation.

3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties, equipment connections, and access panels.

6. Detail application of field-applied jackets.

7. Detail application at linkages of control devices.

8. Detail field application for each equipment type.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Containers for Insulation material, coverings, cements, adhesives and coatings shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, maximum use temperature, and fire hazard index.

B. Protect against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation. Remove any such damaged and wet insulation from site.

1.05 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section 15815.

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.06 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.07 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of, whichever is longer.

PART 2. PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Flexible Elastomeric:

   a. Aeroflex USA Inc.; Aerocel.

   b. Armacell LLC; AP Armaflex.

   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

2. Mineral-Fiber Blanket Insulation:

   a. CertainTeed Corp.; Duct Wrap.

   b. Johns Manville; Microlite.

   c. Owens Corning; All-Service Duct Wrap.

3. Mineral-Fiber Board Insulation:

   a. CertainTeed Corp.; Commercial Board.

   b. Fibrex Insulations Inc.; FBX.

   c. Johns Manville; 800 Series Spin-Glas.

   d. Knauf Insulation; Insulation Board.

   e. Manson Insulation Inc.; AK Board.

   f. Owens Corning; Fiberglas 700 Series.

4. Mineral-Fiber, Preformed Pipe Insulation:

   a. Fibrex Insulations Inc.; Coreplus 1200.

   b. Johns Manville; Micro-Lok.

   c. Knauf Insulation; 1000 Pipe Insulation.

   d. Owens Corning; Fiberglas Pipe Insulation.

6. Mineral-Fiber, Pipe and Tank Insulation:
    a. CertainTeed Corp.; CrimpWrap.
    b. Johns Manville; MicroFlex.
    c. Knauf Insulation; Pipe and Tank Insulation.
    d. Manson Insulation Inc.; AK Flex.
    e. Owens Corning; Fiberglas Pipe and Tank Insulation.
7. Mineral-Fiber Insulating Cement:
    a. Insulco, Division of MFS, Inc.; Triple I.
    b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
8. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement:
    a. Insulco, Division of MFS, Inc.; SmoothKote.
    b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
    c. Rock Wool Manufacturing Company; Delta One Shot.
9. Flexible Elastomeric and Polyolefin Adhesive:
    a. Aeroflex USA Inc.; Aeroseal.
    b. Armacell LCC; 520 Adhesive.
    c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    d. RBX Corporation; Rubatex Contact Adhesive.
10. Mineral-Fiber Adhesive:
    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.
11. ASJ Adhesive, and FSK Adhesive:
    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.

12. PVC Jacket Adhesive:

    a. Dow Chemical Company (The); 739, Dow Silicone.

    b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

    c. Speedline Corporation; Speedline Vinyl Adhesive.

13. Vapor-Barrier Mastic:

    a. Childers Products, Division of ITW; CP-35.

    b. Foster Products Corporation, H. B. Fuller Company; 30-90.

    c. ITW TACC, Division of Illinois Tool Works; CB-50.

    d. Vimasco Corporation; 749.

14. Lagging Adhesives:

    a. Childers Products, Division of ITW; CP-52.

    b. Foster Products Corporation, H. B. Fuller Company; 81-42.

    c. Vimasco Corporation; 136.

15. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products:

    a. Childers Products, Division of ITW; CP-76.

    b. Foster Products Corporation, H. B. Fuller Company; 30-45.

    c. Pittsburgh Corning Corporation; Pittseal 444.

    d. Vimasco Corporation; 750.

16. Metal Jacket Flashing Sealants:

    a. Childers Products, Division of ITW; CP-76-8.

    b. Foster Products Corporation, H. B. Fuller Company; 95-44..

    c. Vimasco Corporation; 750.

17. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

    a. Childers Products, Division of ITW; CP-76.

19. PVC Jacket:

    a. Johns Manville; Zeston.

    b. P.I.C. Plastics, Inc.; FG Series.

    c. Proto PVC Corporation; LoSmoke.

    d. Speedline Corporation; SmokeSafe.

20. Metal Jacket:

    a. Childers Products, Division of ITW; Metal Jacketing Systems.

    b. PABCO Metals Corporation; Surefit.

    c. RPR Products, Inc.; Insul-Mate.

21. ASJ Tape:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.

    b. Compac Corp.; 104 and 105.

    c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.

    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

22. FSK Tape:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

    b. Compac Corp.; 110 and 111.

    c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.

    d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

23. PVC Tape:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.

    b. Compac Corp.; 130.

c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.

d. Venture Tape; 1506 CW NS.

24. Bands:

a. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.

c. RPR Products, Inc.; Bands.

25. Insulation Pins and Hangers:

a. AGM Industries, Inc.; CWP-1.

b. GEMCO; Cupped Head Weld Pin.

c. Midwest Fasteners, Inc.; Cupped Head.

d. Nelson Stud Welding; CHP

26. Wire:

a. C & F Wire.

b. Childers Products.

c. PABCO Metals Corporation.

d. RPR Products, Inc.

2.02 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

I. Mineral-Fiber, Preformed Pipe Insulation:

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2,. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.03 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.04 ADHESIVES

A. All Adhesives & Sealants: All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

E. ASJ Adhesive, and FSK Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.05 MASTICS

A. All Mastics: All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F .

3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

4. Color: White.

2.06 LAGGING ADHESIVES

A. All Adhesives & Sealants: All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

B. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.

2. Service Temperature Range: Minus 50 to plus 180°F.

3. Color: White.

2.07 SEALANTS

A. All Adhesives & Sealants: All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic

Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

B. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Permanently flexible, elastomeric sealant.

3. Service Temperature Range: Minus 100 to plus 300°F.

4. Color: White or gray.

C. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250°F.

4. Color: Aluminum.

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250°F.

4. Color: White.

2.08 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.

2.09 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.

2. Color: Color-code jackets based on system. .

3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45° and 90°, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

4. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

a. Sheet and roll stock ready for shop or field sizing.

b. Material, finish, and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.

d. Moisture Barrier for Outdoor Applications: 2.5-mil- thick Polysurlyn

e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45° and 90°, short- and long-radius elbows.

3) Tee covers.

4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3”.

2. Thickness: 11.5 mils

3. Adhesion: 90 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbs/inch in width.

6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3”.

2. Thickness: 6.5 mils .

3. Adhesion: 90 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbs/inch in width.

6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2”.

2. Thickness: 6 mils

3. Adhesion: 64 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

4. Elongation: 500 percent.

5. Tensile Strength: 18 lbs/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.020” thick, 3/4” wide with wing or closed seal.

2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper-coated steel pin, fully annealed for capacitor-discharge welding, 0.106” diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106” diameter shank, length to suit depth of insulation indicated with integral 1-1/2” galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030” thick by 2”square.

b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106” diameter shank, length to suit depth of insulation indicated.

c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, nylon sheet, 0.030” thick by 1-1/2” in diameter.

    b. Spindle: Nylon, 0.106” diameter shank, length to suit depth of insulation indicated, up to 2-1/2”.

    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Galvanized carbon-steel sheet, 0.030” thick by 2” square.

    b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106” diameter shank, length to suit depth of insulation indicated.

    c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016” thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2” in diameter.

    a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016” thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2” in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4” wide, stainless steel or Monel.

D. Wire: 0.062” soft-annealed, stainless steel.

2.13 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1” by 1”, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Stainless-Steel Corner Angles: 0.024” thick, minimum 1” by 1”, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and prepare surfaces to be insulated. Remove materials that will adversely affect insulation application. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300°F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300°F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

B. Coordinate insulation installation with the trade installing heat tracing, if any. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3” wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4” o.c.

3. Overlap jacket longitudinal seams at least 1-1/2”. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2” o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4” beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2” below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2”.

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2”.

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2”.

2. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section “Through-Penetration Firestop Systems.”

3.05 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

a. Do not weld anchor pins to ASME-labeled pressure vessels.

b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

c. On tanks and vessels, maximum anchor-pin spacing is 3” from insulation end joints, and 16” o.c. in both directions.

d. Do not overcompress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

f. Impale insulation over anchor pins and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment

approximately 6” from each end. Install wire or cable between two circumferential girdles 12” o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48” o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3”.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer’s recommended adhesive.

2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

3. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6” centers, starting at corners. Install 3/8” diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

4. For Hot Water systems, fabricate boxes from galvanized steel, at least 0.050” thick.

5. For Dual Temperature, Chilled Water or Cold Water Systems, fabricate boxes from stainless steel at least 0.050” thick.

6. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.06 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles. Coordinate with drawings for insulation at locations of pipe expansion.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce

the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated on drawings. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2" over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.07 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6” o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1”, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18” and smaller, place pins along longitudinal centerline of duct. Space 3” maximum from insulation end joints, and 16” o.c.

b. On duct sides with dimensions larger than 18”, place pins 16” o.c. each way, and 3” maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2” from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2” outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50°F at 18’ intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3”.

5. Overlap unfaced blankets a minimum of 2” on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18” o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6” wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6” o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18” and smaller, place pins along longitudinal centerline of duct. Space 3”maximum from insulation end joints, and 16” o.c.

b. On duct sides with dimensions larger than 18” space pins 16”o.c. each way, and 3” maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2” from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2” outward-clinching staples, 1” o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

    b. Install vapor stops for ductwork and plenums operating below 50°F at 18’ intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3”.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6” wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6” o.c.

3.09 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1” overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

    1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where Stainless Steel jackets are indicated, install with 2” overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12” o.c. and at end joints.

3.10 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ exposed to view only: Paint jacket with paint system identified below and as specified in Division 9 painting Sections. Coordinate with Architect.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the “Duct Insulation Schedule, General” Article.

2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment requiring insulation for this project. For large equipment, remove only a portion adequate to determine compliance.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the “Piping Insulation Schedule, General” Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Architect may reject all work if sample work is found to be defective.

3.12 DUCT INSULATION PERFORMANCE , GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, supply and outdoor air.

2. Indoor, concealed return located in non-conditioned space.

3. Indoor, return located in non-conditioned space.

4. Indoor, kitchen hood exhaust.

5. Indoor, exhaust 5’ upstream of isolation damper and between isolation damper and penetration of building exterior.

6. Outdoor, supply, return and air.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1 2004.

2. Factory-insulated flexible ducts.

3. Factory-insulated plenums and casings.

4. Flexible connectors.

5. Vibration-control devices.

6. Factory-insulated access panels and doors.

3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. INSULATION APPLICATION SCHEDULE

1. General: Abbreviations used in the following schedules include:

a. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.

B. DUCT SYSTEMS INSULATION SCHEDULE

1. See schedule on drawings for additional information regarding duct insulation / lining requirements for each system. Refer to schedule below for required insulating values. Where insulation is scheduled, include insulation on all associated plenums, fittings, etc.

DUCT LOCATION	SUPPLY AIR , EXHAUST AIR (DOWN STREAM OF DAMPER) INSULATION INSTALLED R-VALUE (H-FT^2-°F)/BTU	RETURN INSULATION INSTALLED R-VALUE (H-FT^2-°F)/BTU	OUTSIDE AIR INSULATION INSTALLED R-VALUE (H-FT^2-°F)/BTU
EXTERIOR OF BUILDING (NOTE 1,5,6,7)	8	8	-
UNCONDITIONED SPACE (NOTE 1,2,5,6)	6.5	6.5	6.5
INDIRECTLY CONDITIONED SPACE (NOTE 1,3,5)	3.5	-	3.5
CEILING CAVITY / SHAFTS / SOFFITS / MECHANICAL SPACES AND ROOMS (NOTE 1,4,5,6)	3.5	-	3.5
EXPOSED LOCATIONS WITHIN CONDITIONED SPACE (NOTE 1,5)	3.5	-	3.5

NOTE 1: INSULATION R-VALUES, MEASURED IN (H X FT^2 X F)/BTU, ARE FOR THE INSULATION AS INSTALLED AND DO NOT INCLUDE FILM RESISTANCE. INSULATION RESISTANCE MEASURED ON A HORIZONTAL PLANE IN ACCORDANCE WITH ASTM C518 AT A MEAN TEMPERATURE OF 75F AT THE INSTALLED THICKNESS.

NOTE 2: INCLUDING CRAWL SPACES (BOTH VENTILATED/NON-VENTILATED), FRAMED CAVITIES IN WALLS, FLOOR AND CEILING ASSEMBLIES WHICH (A) SEPARATE CONDITIONED SPACE FROM UNCONDITIONED SPACE OR OUTSIDE AIR, AND (B) ARE UNINSULATED ON THE SIDE FACING AWAY FROM CONDITIONED SPACE.

NOTE 3: RETURN AIR PLENUMS WITH OR WITHOUT EXPOSED ROOFS ABOVE.

NOTE 4: CAVITY CONTAINED WITHIN THE INSULATED BUILDING ENVELOPE.

NOTE 5: VAPOR BARRIER REQUIRED.

NOTE 6: WITHIN MECHANICAL ROOMS PROVIDE MINERAL FIBER BOARD WITH ALL SERVICE JACKET IN EXPOSED LOCATIONS IN LIEU OF MINERAL FIBER BLANKET.

NOTE 7: STAINLESS STEEL FIELD APPLIED JACKET WITH ALL SEAMS AND JOINTS SEALED WEATHER TIGHT.

3.14 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that are not factory insulated. Follow thickness indicated in Piping Insulation Schedule.

1. Glass fiber insulation with vapor barrier.

2. Flexible Elastomeric.

3.15 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.

2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.16 PIPING INSULATION SCHEDULE

A. Abbreviations used in the following schedules include:

1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.

2. Pipe Sizes: NPS - Nominal Pipe Size.

B. Minimum HVAC pipe insulation thickness: Chilled Water 1-1/2”

1. Glass fiber insulation with vapor barrier.

2. For piping exposed to outdoor air, increase insulation thickness by 1”.

3. Insulation thickness is based on insulation having a thermal conductivity of 0.22 to 0.25 BTU-inch/(h-ft2°F) on a flat surface at a mean temperature of 75°F.

4. (P), (A) or (SS) Field-Applied Jacket on outdoor installations, exposed and concealed.

C. Minimum HVAC pipe insulation thickness: Refrigerant 1-1/2”

1. Flexible elastomeric insulation with UV protection.

2. Insulation thickness is based on insulation having a thermal conductivity of 0.22 to 0.25 BTU-inch/(h-ft2°F) on a flat surface at a mean temperature of 75°F.

END OF SECTION 15083

SECTION 15085 - PLUMBING PIPING INSULATION

PART 1. GENERAL

1.01 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.

2. Domestic hot-water and hot water return piping.

3. Storm Piping

4. Supplies and drains for handicap-accessible lavatories and sinks.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

3. Detail removable insulation at piping specialties, equipment connections, and access panels.

4. Detail application of field-applied jackets.

5. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12” (300 mm) long by NPS 2 (DN 50).

2. Jacket Materials for Pipe: 12” (300 mm) long by NPS 2 (DN 50).

3. Sheet Jacket Materials: 12” (300 mm) square.

4. Manufacturer’s Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Qualification Data: For qualified Installer.

E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

F. Field quality-control reports.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 10’ (3-m) section of NPS 2 (DN 50) straight pipe.

b. One each of a 90° threaded, welded, and flanged elbow.

c. One each of a threaded, welded, and flanged tee fitting.

d. One NPS 2 (DN 50) or smaller valve, and one NPS 2-1/2 (DN 65) or larger valve.

e. Four support hangers including hanger shield and insert.

f. One threaded strainer and one flanged strainer with removable portion of insulation.

g. One threaded reducer and one welded reducer.

h. One pressure temperature tap.

i. One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.

3. Notify Architect seven days in advance of dates and times when mockups will be constructed.

4. Obtain Architect's approval of mockups before starting insulation application.

5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

7. Demolish and remove mockups when directed.

D. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.05 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 15 Section “Hangers and Supports for Plumbing Piping and Equipment.”

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.06 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2. PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in “Piping Insulation Schedule, General” and “Indoor Piping Insulation Schedule” articles for where insulating materials shall be applied.

B. See “Product Characteristics” Article in Evaluations for comparisons and temperature ranges for insulation material properties.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.

b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000-Degree Pipe Insulation.

d. Manson Insulation Inc.; Alley-K.

e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850°F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide the following:

a. Ramco Insulation, Inc.; Super-Stik.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.

b. Armacell LLC; Armaflex 520 Adhesive.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.

d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers,” including 2004 Addenda.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.

b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.

d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.

b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.

d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.

b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

c. P.I.C. Plastics, Inc.; Welding Adhesive.

d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.

b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82°C).

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

2.05 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.

b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.

c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.

4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82°C).

5. Color: White.

2.06 SEALANTS

A. Joint Sealants:

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.07 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.08 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.

c. Compac Corporation; 104 and 105.

d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3” (75 mm).

3. Thickness: 11.5 mils (0.29 mm).

4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.09 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.

b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015” (0.38 mm) thick, 1/2” (13 mm) wide with wing seal.

3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020” (0.51 mm) thick, 1/2” (13 mm) wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4” (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080” (2.0-mm) nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. C & F Wire.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Engineered Brass Company.

b. McGuire Manufacturing.

c. Plumberex.

d. Truebro; a brand of IPS Corporation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Truebro; a brand of IPS Corporation.

b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3. EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300°F (60 and 149°C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300°F (0 and 149°C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3” (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4” (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1-1/2” (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2” (50 mm) o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer’s written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4” (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2” (50 mm) below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 7 Section “Through-Penetration Firestop Systems” for firestopping and fire-resistive joint sealers.

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent

pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2” (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation

with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6” (150 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer’s recommended adhesive, overlap seams at least 1” (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

3.08 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.09 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the “Piping Insulation Schedule, General” Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor’s option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Underground piping.

2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water and Industrial Cold Water (ICW):

1. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1” (25 mm) thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1” (25 mm) thick.

2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1” (25 mm) thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1” (25 mm) thick.

B. Domestic Hot Water:

1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1” (25 mm) thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1” (25 mm) thick.

2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1-1/2” (38 mm) thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2” (38 mm) thick.

C. Storm Piping and Subsoil Drainage Piping (included pumped) within the building:

1. All sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1” (25 mm) thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1” (25 mm) thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1” (25 mm) thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1” (25 mm) thick.

END OF SECTION 15085

SECTION 15111 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Bronze ball valves.
2. Bronze swing check valves.
3. Sump pump discharge valve assembly
4. Balancing valve.
5. Bronze gate valves.

B. Related Sections:
1. Division 2 water distribution piping Sections for general-duty and specialty valves for site construction piping.
2. Division 15 plumbing piping Sections for specialty valves applicable to those Sections only.
3. Division 15 Section “Identification for Plumbing Piping and Equipment” for valve tags and schedules.

1.02 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.03 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.04 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

D. Comply with Public Law 111-380, the Reduction of Lead in Drinking Water Act.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

E. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Hammond Valve.
   d. Lance Valves; a division of Advanced Thermal Systems, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig (1035 kPa).
   c. CWP Rating: 600 psig (4140 kPa).
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.03 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.

2.04 SUMP PUMP DISCHARGE VALVE ASSEMBLY

B. Class 125, Cast Iron:
1. Manufacturer to match sump pump.

2. Description: two 90 degree ball check valves and four-way isolation valve with lockable handle
3. Separate gate valves and swing check valves with non-slam spring and counter weight provisions are acceptable

2.05 BALANCING VALVE

A. Class 200, NRS Bronze Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Bell & Gossett.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   j. Zy-Tech Global Industries, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Material: ASTM B 62, bronze with integral seat.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Packing: Asbestos free.
   g. With differential read-out ports, drain/purge port, and memory stop.

2.06 BRONZE GATE VALVES

B. Class 125, NRS Bronze Gate Valves, pipe sizes 2 1/2” and larger:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Hammond Valve.
   f. Kitz Corporation.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Red-White Valve Corporation.
   k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   l. Zy-Tech Global Industries, Inc.
2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for gate valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball or gate valves.
2. Throttling Service: ball valves.
3. Pump-Discharge Check Valves:
a. All Pipe Sizes: Bronze swing check valves with bronze or nonmetallic disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. All Pipe Sizes:
1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125 Class 150, bronze disc.
3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 125 Class 150, nonmetallic disc.
5. Bronze Gate Valves: Class 125, RS.

END OF SECTION 15111

SECTION 15112 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Brass ball valves.
2. Iron ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Iron, center-guided check valves.
8. Chainwheels.

B. Related Sections:
1. Section 15077 “Identification for HVAC Piping and Equipment” for valve tags and schedules.

1.02 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.04 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.05 DELIVERY, STORAGE, AND HANDLING

C. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

D. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

E. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.
4. Wrench: For plug valves with square heads.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the “Valve Installation” Article.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.

3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. DynaQuip Controls.
   d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
   e. Hammond Valve.
   f. Jamesbury; a subsidiary of Metso Automation.
   g. Jomar International, LTD.
   h. Kitz Corporation.
   i. Legend Valve.
   j. Marwin Valve; a division of Richards Industries.
   k. Milwaukee Valve Company.
   l. NIBCO INC.
   m. Red-White Valve Corporation.
   n. RuB Inc.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig (1035 kPa).
   c. CWP Rating: 600 psig (4140 kPa).
   d. Body Design: Two piece.
   e. Body Material: Forged brass.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Brass.
   i. Ball: Chrome-plated brass.
   j. Port: Full.

2.03 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Kitz Corporation.
   d. Sure Flow Equipment Inc.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-72.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Split body.

d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.04 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
   b. Bray Controls; a division of Bray International.
   c. Conbraco Industries, Inc.; Apollo Valves.
   d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
   e. Crane Co.; Crane Valve Group; Jenkins Valves.
   f. Crane Co.; Crane Valve Group; Stockham Division.
   g. DeZurik Water Controls.
   h. Hammond Valve.
   i. Kitz Corporation.
   j. Milwaukee Valve Company.
   k. NIBCO INC.
   l. Norriseal; a Dover Corporation company.
   m. Red-White Valve Corporation.
   n. Spence Strainers International; a division of CIRCOR International.
   o. Tyco Valves & Controls; a unit of Tyco Flow Control.
   p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 150 psig (1035 kPa).
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.

2.05 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.

d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.06 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Sure Flow Equipment Inc.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.07 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. APCO Willamette Valve and Primer Corporation.
   c. Crispin Valve.
   d. DFT Inc.
   e. Flo Fab Inc.
   f. GA Industries, Inc.
   g. Hammond Valve.
   h. Metraflex, Inc.
   i. Milwaukee Valve Company.
   j. Mueller Steam Specialty; a division of SPX Corporation.
   k. NIBCO INC.
   l. Spence Strainers International; a division of CIRCOR International.
   m. Sure Flow Equipment Inc.
   n. Val-Matic Valve & Manufacturing Corp.
   o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-125.
   b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
   c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
   d. Body Material: ASTM A 126, gray iron.
   e. Style: Compact wafer.
   f. Seat: Bronze.

2.08 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

B. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service except Steam: Calibrated balancing valves.
4. Pump-Discharge Check Valves:
   a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with nonmetallic disc.
   b. NPS 2-1/2 (DN 65) and Larger: Iron center-guided, metal-seat check valves.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

D. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.05 HVAC VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass with brass trim.
3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 (DN 65) and larger: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron, Center-Guided Check Valves: Class 125, compact-wafer, metal seat.

END OF SECTION 15112

SECTION 15127 - METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Thermometers.
2. Gauges.
3. Test plugs.
4. Thermowells.

1.02 DEFINITIONS – NOT APPLICABLE

1.03 SUBMITTALS

A. Product Data: For each type of product indicated; include scale range, ratings, and calibrated performance curves, certified where indicated. Submit a meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter.

B. Shop Drawings: Schedule for thermometers and gauges indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer and gauge, signed by product manufacturer.

1.04 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

B. Design Criteria: The Drawings indicate types, sizes, capacities, ranges, profiles, connections, and dimensional requirements of meters and gauges and are based on the specific manufacturer types and models indicated. Meters and gauges having equal performance characteristics by other manufacturers may be considered, provided that deviations do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of meters and gauges is on the proposer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer's instructions for job site storage and protection of materials during construction.

1.06 WARRANTY

A. Written manufacturer's warranty covering parts and labor for a period of one year from, or eighteen months from shipment, whichever is longer.

PART 2 PRODUCTS

2.01 Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

A. Metal-Case, Liquid-in-Glass Thermometers:
1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Duct-Type, Liquid-in-Glass Thermometers:
1. Miljoco Corp.
2. Palmer - Wahl Instruments Inc.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.

C. Direct-Mounting, Vapor-Actuated Dial Thermometers:
1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

D. Remote-Mounting, Vapor-Actuated Dial Thermometers:
1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

E. Bimetallic-Actuated Dial Thermometers:
1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

F. Thermowells:
1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

G. Pressure Gauges:
1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

H. Test Plugs:
1. MG Piping Products Co.
2. Trerice, H. O. Co.

3. Watts Industries, Inc.; Water Products Div.

2.02 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. General: Provide liquid-in-glass thermometers complying with ASTM E1.

B. Case: Die-cast aluminum, 9 inches long.

C. Tube: Red reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.03 DUCT-TYPE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Die-cast aluminum, 7 inches long.

B. Tube: Red reading, organic filled, with magnifying lens.

C. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

D. Window: Glass.

E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Stem: Metal, for installation in mounting bracket and of length to suit installation.

G. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.04 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Drawn steel or cast aluminum metal or plastic, 4-1/2-inch diameter.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Metal.

H. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

I. Thermal System: Organic liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.05 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Metal.

H. Connector: Bottom union type.

I. Thermal System: Organic liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.06 THERMOWELLS

A. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

B. Stem length: Extend 2 inches into the fluid or into the center of the pipe. Extension for insulated pipe shall be 2 inches nominal, but not less than the thickness of the insulation.

C. Provide threaded cap nut with chain permanently fastened to well and cap.

2.07 PRESSURE GAUGES

A. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.
1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

B. Pressure-Gauge Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS ¼ brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.08 TEST PLUGS

A. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

B. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

C. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

D. Test Kit: Furnish one test kit containing one pressure gauge and adaptor, two thermometers, and carrying case. Pressure gauge, adapter probes, and

thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gauge: Small bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer (Chilled water): Small bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer (Heating/domestic hot water): Small bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 EXECUTION

3.01 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations and elsewhere as noted:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Outside-air, return-air, and mixed-air ducts.

B. Install direct-mounting, vapor-actuated dial thermometers in the following locations and elsewhere as noted:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.

C. Install dry-case-type, vapor-actuated dial thermometers at suction and discharge of each pump.

D. Provide the following temperature ranges for thermometers:
1. Heating Hot Water (Non-condensing boiler applications): 30 to 300 deg F, with 2-degree scale divisions (Minus 1 to plus 150 deg C, with 1-degree scale divisions).Heating Hot Water (Condensing boiler applications): 30 to 220 deg F, with 2-degree scale divisions (Minus 1 to plus 105 deg C, with 1-degree scale divisions).
2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions).
3. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions (Minus 40 to plus 43 deg C, with 1-degree scale divisions).
4. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions (Minus 1 to plus 115 deg C, with 1-degree scale divisions).
5. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions).

3.02 GAUGE APPLICATIONS

A. Install dry-case-type pressure gauges for discharge of each pressure-reducing valve.

B. Install dry-case-type pressure gauges at chilled- and condenser-water inlets and outlets of chillers.

C. Install dry-case-type pressure gauges at suction and discharge of each pump.

3.03 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

E. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

F. Install remote-mounting pressure gauges on panel.

G. Install needle-valve and snubber fitting in piping for each pressure gauge for fluids (except steam).

H. Install needle-valve and syphon fitting in piping for each pressure gauge for steam.

I. Install test plugs in tees in piping.

J. Install permanent indicators on walls or brackets in accessible and readable positions.

K. Install connection fittings for attachment to portable indicators in accessible locations.

3.04 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance for meters, gauges, machines, and equipment.

B. Apply conductive pate to the thermometer or temperature sensor prior to installing it in the thermowell.

3.05 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gauges to proper angle for best visibility.

END OF SECTION 15127

SECTION 15140 - DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Flexible connectors.
5. Water meters.

B. Related Section:
1. Division 2 Section “Water Distribution” for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.
2. 15060 Pipe and Pipe Fittings for ICW and ICWR pipe and fittings.
3. 15083 HVAC Insulation for ICW and ICWR insulation.

1.02 SUBMITTALS

A. Product Data: For the following products:
1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Water meters.
6. Backflow preventers.
7. Water penetration systems.

B. Water Samples: Specified in “Cleaning” Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Domestic water piping.

D. Field quality-control reports.

1.03 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

C. Comply with Public Law 111-380, the Reduction of Lead in Drinking Water Act.

1.04 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Owner's written permission.

1.05 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
   1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
   5. Copper Pressure-Seal-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Elkhart Products Corporation; Industrial Division.
         2) NIBCO INC.
         3) Viega; Plumbing and Heating Systems.
      b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
   1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2. Copper Pressure-Seal-Joint Fittings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Elkhart Products Corporation; Industrial Division.
      2) NIBCO INC.
      3) Viega; Plumbing and Heating Systems.
   b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   c. NPS 3 and NPS 4 (DN 80 and DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.03 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
   2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
      a. Gaskets: AWWA C111, rubber.
   2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
      a. Gaskets: AWWA C111, rubber.

2.04 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.05 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Sheet or Tube.

C. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness or high-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.

D. Color: Black or Natural.

2.06 SPECIALTY VALVES

A. Comply with requirements in Division 15 Section “General-Duty Valves for Plumbing Piping” for general-duty metal valves.

B. Comply with requirements in Division 15 Section “Domestic Water Piping Specialties” for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.07 TRANSITION FITTINGS

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Dresser Piping Specialties.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc; a Sensus company.
g. Viking Johnson; c/o Mueller Co.

2.08 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:
   a. Pressure Rating: 150 psig (1035 kPa) at 180 deg F (82 deg C).
   b. End Connections: Solder-joint copper alloy and threaded ferrous.

2.09 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Flex Pression, Ltd.
   4. Flex-Weld, Inc.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.10 WATER METERS

A. Displacement-Type Water Meters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AALIANT; a Venture Measurement Product Line.
      b. ABB.
      c. Badger Meter, Inc.
   2. Description:
      a. Standard: AWWA C700.
      b. Pressure Rating: 150-psig (1035-kPa) working pressure.
      c. Body Design: Nutating disc; totalization meter.
      d. Registration: In cubic feet.
      e. Case: Bronze.
      f. End Connections: Threaded.

B. Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly.

PART 3 EXECUTION

3.01 EARTHWORK

A. Comply with requirements in Division 2 Section “Earthwork” for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA’s “Copper Tube Handbook.”

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements for pressure gages and Division 15 Section “Domestic Water Piping Specialties” for drain valves and strainers.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install domestic water piping level and plumb.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump.

R. Install thermometers on inlet and outlet piping from each water heater.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.03 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
   3. Approved joint sealer Manufacturers and Models: Subject to compliance with the above specified requirements:
      a. Loctite PST565 for sizes up to 2” NPT.
      b. Loctite PST564 for sizes greater than 2” NPT.

D. Brazed Joints: Join copper tube and fittings according to CDA’s “Copper Tube Handbook,” “Brazed Joints” Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA’s “Copper Tube Handbook.”

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Steel-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 15 Section “General-Duty Valves for Plumbing Piping” for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly or gate valves for piping NPS 2-1/2 (DN 65) and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section “Domestic Water Piping Specialties.”
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
   2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.05 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
   2. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.06 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

3.07 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to domestic water pump.

B. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.08 WATER METER INSTALLATION

A. Rough-in domestic water piping for water meter installation, and install water meter.

B. Install water meters according to AWWA M6, and the following:

C. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

D. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

3.09 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 15 Section “Hangers and Supports for Plumbing Piping and Equipment” for pipe hanger and support products and installation.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

C. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.

3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

D. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Domestic Water Booster Pump: Cold-water suction and discharge piping.
2. Water Heater: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 15 Section “Identification for Plumbing Piping and Equipment” for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Industrial Cold Water and Return (ICW & ICWR) piping, insulation, valves, accessories, hangers to meet general mechanical specifications, HVAC, and Plumbing specific where applicable.

D. Under-building-slab, domestic water, building service piping, NPS 3 (DN 80) and smaller, shall be the following:
1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:
1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

F. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
1. Soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed joints.

G. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) ; copper push-on-joint fittings; and push-on joints.

H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint copper-tube appurtenances; and grooved joints.

4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

3.16 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use ball or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   2. Throttling Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 15140

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
2. Backflow preventers.
3. Temperature-actuated water mixing valves.
4. Strainers.
5. Drain valves.
6. Water hammer arresters.
7. Air vents.
8. Sleeves.
9. Escutcheons.
10. Pressure Gauges.

B. Related Sections include the following:
1. Division 15 Section “Domestic Water Piping” for water meters.

1.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. NSF Compliance:
1. Comply with NSF 61, “Drinking Water System Components - Health Effects; Sections 1 through 9.”

B. Comply with Public Law 111-380, the Reduction of Lead in Drinking Water Act.

PART 2 PRODUCTS

2.01 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

2.02 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. FEBCO; SPX Valves & Controls.
      c. Watts Industries, Inc.; Water Products Div.
      d. Zurn Plumbing Products Group; Wilkins Div.
   2. Standard: ASSE 1012.
   3. Operation: Continuous-pressure applications.
   4. Size: NPS 3/4 (DN 20).
   5. Body: Bronze.
   6. End Connections: Union, solder joint.
   7. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers (RPZ) :
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Conbraco Industries, Inc.
      b. FEBCO; SPX Valves & Controls.w
      c. Watts Industries, Inc.; Water Products Div.
      d. Zurn Plumbing Products Group; Wilkins Div.
   2. Standard: ASSE 1013.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
   5. Size: Refer to drawings.
   6. Body: Bronze for NPS 2 (DN 50) and smaller; stainless steel for NPS 2-1/2 (DN 65) and larger.
   7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   8. Configuration: Designed for horizontal, straight through flow.
   9. Accessories:

a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check Backflow-Prevention Assemblies :
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
a. Conbraco Industries, Inc.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Size: Refer to Drawings.
6. Body: Bronze for NPS 2 (DN 50) and smaller; stainless steel for NPS 2-1/2 (DN 65) and larger.
7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

D. Dual-Check-Valve Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2 (DN 15).
5. Body: Bronze with union inlet.

E. Hose-Connection Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.
b. Watts Industries, Inc.; Water Products Div.
c. Woodford Manufacturing Company.

2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water (30-kPa) back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm (0.19-L/s) flow.

F. Backflow-Preventer Test Kits :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.03 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves :
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
a. Lawler Manufacturing Company, Inc.
b. Powers; a Watts Industries Co.
c. Symmons Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa).
4. Type: Exposed-mounting, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
9. Valve Finish: Rough bronze.
10. Piping Finish: Copper.

B. Individual-Fixture, Water Tempering Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.
b. Lawler Manufacturing Company, Inc.
c. Leonard Valve Company.
d. Powers; a Watts Industries Co.
e. Watts Industries, Inc.; Water Products Div.
f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1016/1070, thermostatically controlled water tempering valve.

3. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

2.04 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers :
1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm) .
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
6. Drain: Pipe plug or Factory-installed, hose-end drain valve.

2.05 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves :
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves :
1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.06 WATER HAMMER ARRESTERS

A. Water Hammer Arresters :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. PPP Inc.
   d. Sioux Chief Manufacturing Company, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.07 AIR VENTS

A. Bolted-Construction Automatic Air Vents :
   1. Body: Bronze.
   2. Pressure Rating: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
   3. Float: Replaceable, corrosion-resistant metal.
   4. Mechanism and Seat: Stainless steel.
   5. Size: NPS 1/2 (DN 15) minimum inlet.
   6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents :
   1. Body: Stainless steel.
   2. Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.
   3. Float: Replaceable, corrosion-resistant metal.
   4. Mechanism and Seat: Stainless steel.
   5. Size: NPS 3/8 (DN 10) minimum inlet.
   6. Inlet and Vent Outlet End Connections: Threaded.

2.08 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends an integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

E. Molded-PE or –PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.09 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

2.10 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMETEK, Inc.; U.S. Gauge.
      b. Ashcroft Inc.
      c. Ernst Flow Industries.
      d. Flo Fab Inc.
      e. Marsh Bellofram.
      f. Miljoco Corporation.
      g. Noshok.
      h. Palmer Wahl Instrumentation Group.
      i. REOTEMP Instrument Corporation.
      j. Tel-Tru manufacturing Company.
      k. Trerice, H.O. Co.
      l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      m. Weiss Instruments, Inc.
      n. WIKA Instrument Corporation – USA.
      o. Winters Instruments – U.S.
   2. Standard: ASME B40.100.
   3. Case: Liquid-filled type(s); cast aluminum or drawn steel 4-1/2-inch (114-mm) nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN8 or DN15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
   8. Pointer: Dark-colored metal.
   9. Window: Plastic.
   10. Ring: Stainless steel.
   11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Division 15 Section “Basic Mechanical Materials and Methods” for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.

E. Install air vents at high points of water piping.

3.02 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or –PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 7 Section “Joint Sealants.”

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Comply with requirements for fire-stopping specified in Division 7 Section “Through-Penetration Firestop Systems.”

3.03 ESCUTCHEON INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
1. Escutcheons for New Piping:
a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome plated finish.
c. Insulated Piping: One-piece split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece or split-casting brass type with polished, chrome-plated finish.

3.04 PRESSURE GAGE INSTALLATION

A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

B. Install thermometers in the following location:
1. Inlet and outlet of each water heater.

C. Install pressure gages in the following locations:
1. Building water service entrance into building.
2. Suction and discharge of domestic water pump.

3.05 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

3.06 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Double-check backflow-prevention assemblies.
2. Dual-check-valve backflow preventers.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section “Mechanical Identification.”

3.07 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
1. Test each double-check backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

C. Replace broken and damaged escutcheons and floor plates using new materials.

3.08 ADJUSTING

A. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

B. Adjust faces of gages to proper angle for best visibility.

3.09 PRESSURE-GAGE SCALE RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1100 kPa).

B. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1100 kPa).

END OF SECTION 15145

SECTION 15150 - SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:
1. Division 2 Section “Sanitary Sewerage” for sanitary sewerage piping and structures outside the building.

1.02 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, “Plastics Piping Systems Components and Related Materials,” for plastic piping components. Include marking with “NSF-dwv” for plastic drain, waste, and vent piping and “NSF-sewer” for plastic sewer piping.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Architect's and Owner's written permission.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Dallas Specialty & Mfg. Co.
      c. Fernco Inc.
      d. Matco-Norca, Inc.
      e. MIFAB, Inc.
      f. Mission Rubber Company; a division of MCP Industries, Inc.
      g. Stant.
      h. Tyler Pipe.
   2. Standards: ASTM C 1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ANACO-Husky.
b. Clamp-All Corp.
c. Dallas Specialty & Mfg. Co.
d. MIFAB, Inc.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Stant.
g. Tyler Pipe.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include threaded ends matching joining method.

B. Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:
1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.05 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M (ASTM B 88M, Type B and Type C), water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

E. Copper Pressure Fittings:
   1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.06 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.07 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Non-pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Dallas Specialty & Mfg. Co.
      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.
      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   b. Standard: ASTM C 1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. 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.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Capitol Manufacturing Company.
      2) Central Plastics Company.
      3) Hart Industries International, Inc.
      4) Jomar International Ltd.
      5) Matco-Norca, Inc.
      6) McDonald, A. Y. Mfg. Co.
      7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      8) Wilkins; a Zurn company.
   b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 150 psig.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

2.08 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) minimum thickness.

C. Form: Sheet.

D. Color: Black.

PART 3 EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 2 Section “Earthwork.”

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and

short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

M. Install steel piping according to applicable plumbing code.

N. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground PVC piping according to ASTM D 2321.

R. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 15 Section "Sanitary Waste Piping Specialties."

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 15 Section “Sanitary Waste Piping Specialties.”

S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

T. Install sleeves for piping penetrations of walls, ceilings, and floors.

U. Install sleeve seals for piping penetrations of concrete walls and slabs.

V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's “Cast Iron Soil Pipe and Fittings Handbook” for compression joints.

B. Join 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.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI’s “Cast Iron Soil Pipe and Fittings Handbook” for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.

2. In Drainage Piping: Unshielded, non-pressure transition couplings.

B. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges and nipples.

3.05 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 15 Section “Hangers and Supports for Plumbing Piping and Equipment.”
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42 clamps.
4. Install individual, straight, horizontal piping runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer than 100 Feet (30 m) if indicated: MSS Type 49, spring cushion rolls.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.

C. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.

E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.

4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.

F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.07 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 15 Section “Identification for Plumbing Piping and Equipment.”

3.08 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.09 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper tube, copper drainage fittings, and soldered joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

3. Copper tube, copper drainage fittings, and soldered joints.
   a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

E. Aboveground, vent piping NPS 5 (DN 125) and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Service class, cast-iron soil piping; gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

END OF SECTION 15150

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Roof flashing assemblies.
   4. Through-penetration firestop assemblies.
   5. Miscellaneous sanitary drainage piping specialties.
   6. Flashing materials.

B. Related Sections include the following:
   1. Division 15 Section “Plumbing Fixtures.”

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
   1. Cleanouts.
   2. Floor drains.

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

C. Retain first paragraph below if Contractor is responsible for field quality-control testing.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, “Plastics Piping Components and Related Materials,” for plastic sanitary piping specialty components.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal Cleanouts :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hub-and-spigot, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk or raised-head, plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
      d. Watts Drainage Products Inc.

e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron .
6. Clamping Device: Required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Polished bronze .
11. Frame and Cover Shape: Round .
12. Top Loading Classification: Extra Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: As required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains :

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.
3. Pattern: Floor Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
10. Sediment Bucket: Required.
11. Top or Strainer Material: Nickel bronze.
12. Top of Body and Strainer Finish: Nickel bronze Polished bronze Rough bronze.
13. Top Shape: Round.
14. Top Loading Classification: Heavy Duty.
15. Funnel: Not required.
16. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
17. Trap Material: Bronze .
18. Trap Pattern: Deep-seal P-trap.
19. In sensitive occupied spaces and as indicated on plans provide backwater valve insert, Watts BV-1000 or equal, with neoprene gasket and bronze hardware

2.03 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies :
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-) thick, lead flashing collar and skirt extending at least 8 inches (200 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.04 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies :
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.05 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains :
1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps :
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
   b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Sleeve Flashing Device :
1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

2.06 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm) thickness.
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm) thickness.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
   b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
   c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Assemble open drain fittings and install with top of hub 1 inch (25 mm) above floor.

G. Install deep-seal traps on floor drains and other waste outlets, if indicated.

H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install vent caps on each vent pipe passing through roof.

K. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

L. Install wood-blocking reinforcement for wall-mounting-type specialties.

M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section “Sheet Metal Flashing and Trim.”

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.04 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 PROTECTION

A. Protect drains during of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work. If drains must be used during construction, put strainer product in place.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15155

SECTION 15160 - STORM DRAINAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:
1. Section 02510 “Utilities” for storm drainage piping outside the building.
2. Section 15446 “Sump Pumps” for storm drainage pumps.
3. Section 15150 “Sanitary Waste Specialties” for cleanouts.

1.02 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
1. Storm Drainage Piping: 10-foot head of water (30 kPa).
2. Storm Drainage, Force-Main Piping: 50 psig (345 kPa).
3. Subsoil Drain piping
a. Perforated-wall pipe and fittings
b. Drain pipe
c. Geotextile filter fabrics

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, “Plastics Piping System Components and Related Materials,” for plastic piping components. Include marking with “NSF-drain” for plastic drain piping and “NSF-sewer” for plastic sewer piping.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in “Piping Schedule” Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Dallas Specialty & Mfg. Co.
   c. Fernco Inc.
   d. Matco-Norca, Inc.
   e. MIFAB, Inc.
   f. Mission Rubber Company; a division of MCP Industries, Inc.
   g. Stant.
   h. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Clamp-All Corp.
   c. Dallas Specialty & Mfg. Co.
   d. MIFAB, Inc.
   e. Mission Rubber Company; a division of MCP Industries, Inc.
   f. Stant.
   g. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12 threaded.

C. Steel-Pipe Pressure Fittings:
1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Galvanized, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products.
d. Victaulic Company.

2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged-steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.05 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:
1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-On-Joint Piping:
1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:
1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
2. Ductile-Iron-Pipe Appurtenances:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Anvil International.
2) Shurjoint Piping Products.
3) Star Pipe Products.
4) Victaulic Company.

b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.06 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

E. Copper Pressure Fittings:
1. Copper Fittings: ASME B16.18, cast-copper-alloy fittings or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.07 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.
1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Solvent Cement: ASTM D 2564.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.08 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Dallas Specialty & Mfg. Co.
      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.
      4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

   b. Standard: ASTM C 1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. 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.
4. Shielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company; a division of MCP Industries, Inc.
   b. Standard: ASTM C 1460.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Dresser, Inc.
      3) EBAA Iron, Inc.
      4) Ford Meter Box Company, Inc. (The)
      5) JCM Industries, Inc.
      6) Romac Industries, Inc.
      7) Smith-Blair, Inc.; a Sensus company.
      8) Viking Johnson; c/o Mueller Co.

   b. Standard: AWWA C219.
   c. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
   d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
4) Jomar International Ltd.
5) Matco-Norca, Inc.
6) McDonald, A. Y. Mfg. Co.
7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
8) Wilkins; a Zurn company.

b. Description:
1) Standard: ASSE 1079.
2) Pressure Rating: 150 psig (1035 kPa).
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Matco-Norca, Inc.
4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
5) Wilkins; a Zurn company.
b. Description:
1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 150 psig (1035 kPa).
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Advance Products & Systems, Inc.
2) Calpico, Inc.

3) Central Plastics Company.
4) Pipeline Seal and Insulator, Inc.

b. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig (1035 kPa).
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Elster Perfection.
2) Grinnell Mechanical Products.
3) Matco-Norca, Inc.
4) Precision Plumbing Products, Inc.
5) Victaulic Company.

b. Description:
1) Electroplated steel nipple complying with ASTM F 1545.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

2.09 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) or LLDPE film of 0.008-inch (0.20-mm) minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

2.10 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.
1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 02300 “Earthwork.”

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

O. Install steel piping according to applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install aboveground ABS piping according to ASTM D 2661.

R. Install aboveground PVC piping according to ASTM D 2665.

S. Install underground PVC piping according to ASTM D 2321.

T. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
1. Install encasement on piping according to ASTM A 674 or AWWA C105.

U. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
1. Install encasement on piping according to ASTM A 674 or AWWA C105.

V. Install force mains at elevations indicated.

W. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 15165 "Storm Drainage Piping Specialties."
2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 15165 "Storm Drainage Piping Specialties."

X. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Y. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves on Plumbing Drawing (P-12)."

Z. Deleted

AA. Install Install escutcheons for piping penetrations of walls, ceilings, and floors.Comply with the following:

1. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
2. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge."

BB. Subsoil drainage piping to be installed with perforations on bottom half of pipe.

3.03 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
3. Approved joint sealer Manufacturers and Models: Subject to compliance with the above specified requirements:
   a. Loctite PST565 for sizes up to 2" NPT.
   b. Loctite PST564 for sizes greater than 2" NPT.

E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in ODs.
   2. In Drainage Piping: Unshielded, nonpressure transition couplings.
   3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
   4. In Underground Force-Main Piping:
      a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
      b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   2. Dielectric Fittings for all sizes: Use dielectric nipples unions, or flanges.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 15111 “General-Duty Valves for Plumbing Piping.”

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
   2. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

3.06 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 “Piping Installation” Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

J. Deleted.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.07 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 15061 “Hangers and Supports for Plumbing Piping and Equipment.”
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
4. Vertical Piping: MSS Type 8 or Type 42, clamps.
5. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
6. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
6. Spacing for 10-foot (3-m) pipe lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.

8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

J. Install supports for vertical copper tubing every 10 feet (3 m).

K. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

L. Install supports for vertical PVC piping every 48 inches (1200 mm).

M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.08 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.
1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

D. Connect force-main piping to the following:
1. Storm Sewer: To exterior force main.
2. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.09 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 15076 “Identification for Plumbing Piping and Equipment.”

3.10 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   4. Prepare reports for tests and required corrective action.

3.11 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Belowground storm drainage force mains shall be any of the following:
   1. Ductile Iron pipe and fittings.

C. Aboveground storm drainage force mains all sizes shall be any of the following:
   1. Hard copper tube, copper pressure fittings, and soldered joints.
   2. Galvanized-steel pipe, pressure fittings, and threaded joints.
   3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
   4. Fitting-type transition couplings if dissimilar pipe materials.

D. Subsoil drainage piping:
   1. Perforated and solid PVC sewer pipe and fittings.

END OF SECTION 15160

1.01 SECTION **15185** - **HYDRONIC PUMPS**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. ITT Corporation; Bell & Gossett.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 15058 "Common Motor Requirements for HVAC Equipment."

2.2 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig (1204-kPa) pressure rating, iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig (1204-kPa) pressure rating, iron body, pump-discharge fitting.
3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment bases.
   1. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install on 4-inch- (100-mm-) high concrete base.

3.3 ALIGNMENT

A. Perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 15182 "Steam and Condensate Piping" and Section 15184 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Ground equipment according to Section 16060 "Grounding and Bonding."

J. Connect wiring according to Section 16120 "Conductors and Cables."

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 15185

SECTION 15300 - FIRE SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The fire protection Subcontractor shall be responsible for all material, labor, logistical and technical resources, and coordination necessary for the complete execution of the work.

B. The work in this section includes but not necessarily limited to:

1. Design/engineering, labor and materials to provide complete wet pipe and pre-action automatic sprinkler systems.

2. Coordination with existing work, restrictions and other trades.

3. Clean-up and mop-up of areas.

4. Complete system draining, filling, and (hydrostatic and air pressure) testing.

C. SYSTEM DESIGN CRITERIA

1. The design of the automatic fire sprinkler systems shall be based on hydraulic calculations conforming to NFPA 13, Ordinary Hazard Group II for Experimental Hall and Group I for the remaining areas and the requirements specified herein.

a. The minimum design density for the Experimental Hall and Detector Hall automatic sprinkler system shall be 0.20 and 0.15 gpm per square foot for the remaining areas, that is, Group II and Group I respectively.

b. The area calculated for the wet-pipe sprinkler systems shall be the hydraulically most remote 1,500 square foot area for the Experimental Hall and 1,950 square feet for the Detector Hall.

c. Hydraulic calculations shall include an allowance of 250 gpm for outside hose streams and 50 gpm for cooling make up water at the 6-inch Industrial Cooling Water (ICW) underground main lead-in into the building.

d. Calculate friction losses in the systems in accordance with the Hazen Williams formula with a "C" value of 120 for wet-pipe. The Detector Hall “C” value of 100 for dry pipe (pre-action).

2. Sprinkler spacing shall not exceed 130 square foot per sprinkler.

3. The hydraulic calculations shall be based on the water supply available at the connection to the 6-inch ICW system.

4. Waterflow test was conducted at this ICW connection near MI-20 Service building on March 24, 2010, and the results are as follows:
   Static: 60 psi
   Residual: 45 psi
   Flow: 955 gpm

1.02 RELATED WORK:

A. The following section prescribes items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

1. Section 16721 – Fire Alarm System.

1.03 APPLICABLE STANDARDS:

A. The publications listed below form part of this Section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. In the publications referenced to herein, the advisory provisions shall be considered mandatory, as though the word “SHALL” had been substituted for “SHOULD” wherever it appears. Reference to the authority having jurisdiction shall be interpreted to read Fermilab. Except as specifically modified by the requirements specified herein or the details on the drawings, the Work included under this Section shall conform to the provisions of these publications:

1. ANSI American National Standards Institute

2. ASTM American Society for Testing and Material

3. AWS American Welding Society

4. National Fire Protection Association (NFPA)

   a) NFPA 13, Standard for the Installation of Sprinkler Systems, 2013

   b) NFPA 72, National Fire Alarm Code, 2013

5. Underwriters Laboratories (UL), Inc.

   1. UL Fire Protection Equipment Directory, 2013

1.04 SUBMITTALS: The requirements of this section supplement the general requirements for As-Built Drawings included in Section 12.0 of Exhibit A.

A. Partial submittals will not be acceptable.

B. Fermilab will review all submittals. Before any work is commenced, submit for review complete sets of installation/working drawings and hydraulic calculations, and applicable supporting material, (i.e. manufacturers' product data for pipe, fittings, valves, sprinklers, hangers, and penetration sealant), prepared in compliance with the applicable publications listed elsewhere in this section.

C. As-Built (Record) Drawings: After completion, but before final acceptance of the work, furnish three (3) complete sets of as-built drawings, including two sets of black lines and one set of reproducible drawings. Also provide a complete set of computer disks of all drawings. All drawings must be produced with AutoCad version 2011 or higher software.

D. Operation and Maintenance Instruction Manual: After completion of the project, furnish three (3) complete sets of operation and maintenance instruction manuals consistent with the system as installed. Manual shall contain complete operation and maintenance instructions for the specific make and model of waterflow, valve and supervisory switches, check valves, sprinklers, control valves, etc.

E. Certificates of Compliance: The Subcontractor shall complete, sign and submit a "Contractor's Material and Test Certificate for Aboveground Piping" identical to that in NFPA 13.

1.05 QUALITY ASSURANCE AND CONTROL:

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 GENERAL:

A. All equipment and system components furnished and installed shall be new and listed by Underwriters Laboratories, Inc. (UL) or approved by Factory Mutual (FM) for their intended use. All such equipment and system components shall be installed within the limitations of the respective UL listings and/or FM approvals. Acceptable sprinkler/component system manufacturers include, unless otherwise specified:

1. Tyco
2. Victualic, groove fittings and couplings
3. Viking, sprinklers & components
4. Stockham, or approved equal, for fittings

2.02 SPRINKLER SYSTEM PIPING

A. Trim Piping - 3/4 inch and Smaller: Steel, Schedule 80, Galvanized, ASTM A53 with threaded ends.

B. Piping

1. Wet Type: 1-inch through 2-inch, steel Schedule 40, Black, ASTM A53 with threaded ends.
2. Wet Type: 2-1/2-inch through 6-inch, steel, Schedule 40, Black, ASTM A53 with rolled or cut groove ends, for use with groove end fittings and couplings.
3. Dry Type: 1-inch through 2-inch galvanized steel Schedule 40, ASTM A53 with galvanized fittings.
4. Dry Type: 2-1/2 inch through 6-inch, galvanized steel Schedule 40 ASTM A53 with rolled or cut groove ends, for use with galvanized groove fittings and couplings.

C. Fittings

i. 1-inch through 2-inch, cast iron, galvanized, and ductile iron, class 150, screwed ASTM A197
ii. 2-1/2-inch and larger shall be:
    a. UL and FM approved grooved (rubber gasketed) couplings and fittings dimensionally compatible with pipe grooves, such as Victaulic style 75 couplings with Victaulic fittings.
    b. Galvanized, Cast iron, and/or ductile iron, threaded flanges and flanged fittings conforming to ANSI B16.1 Class 150.
iii. Plain-end fittings with mechanical couplings which utilize steel gripping devices to bite into the pipe when pressure is applied are not acceptable.

D. Bolting: Square head machine bolts, ASTM A307, Grade B, with heavy hex nuts.

E. Gaskets: Full-faced cellulose fiber and nitrile binder composition, 1/16 inch thick and listed for type of application, (i.e. dry pipe application and wet pipe application).

F. Threaded Joints: Graphite or inert filler and coil; crane thread lubricant or equal. Pipe sections shall be cleaned inside, removing all chips and foreign matter prior to making joints. Pipe dope or Teflon tape shall be applied to pipe threads.

2.03 PIPE HANGERS AND SUPPORTS

A. Pipe hangers shall be clevis or of the approved type and shall be installed in accordance with NFPA 13. Cutting or drilling of structural members for support of piping shall be avoided wherever possible and shall not be done without permission of Fermilab. Provide trapeze hangers where cross or feed mains run parallel with trusses or joists.

B. Provide pipe supports (stands) below system risers and associated valves.

2.04 CHECK VALVES

A. Check valves size 2 inch and smaller shall be screwed, bronze body and trim, regrinding type, horizontal swing valves, rated for 175 psi non-shock cold water service.

B. Check valves size 2-1/2 inch and larger shall be flanged cast iron body, bronze mounted, full opening, horizontal swing, rubber-faced valve, rated for 250 psi non-shock cold water service.. Wafer type check valves with stainless steel spring are also acceptable.

C. Check valves utilized as (main) riser check valves shall be swing check valves provided with ports for gauges on inlet and outlet side of valve, including a drain port for the main drain located on the outlet side of valve.

2.05 GATE VALVES

A. Gate valves 2 inch and smaller shall be screwed bronze body, solid wedge, outside screw and yoke type valves, rated for 175 psi non-shock cold water service.

B. Gate valves size 2-1/2 inch and larger shall be flanged, iron body, bronze trim or with resilient rubber encapsulated wedge, outside screw and yoke type valves, rated for 175 psi non-shock cold water service. Valves shall be capable of being repacked under pressure, with valve in an open position.

C. Provide valve supervisory (tamper) switches on all new sprinkler system control valves. Valve stem shall be pre-grooved for use with supervisory switch. All valves shall be located where easily accessible and installed so as to allow them to be removed and replaced if necessary.

2.06 BUTTERFLY VALVES

A. Butterfly valves shall either be lug, wafer, or groove style body with nickel plated disc and UL-listed or FM-approved for fire protection service. Body shall be ductile iron, stem shall be 400 series stainless steel, gear operated with cast iron indicator flag and steel hand wheel. Valve must be rated for 175 psi non-shock cold water service.

B. Valve must have factory installed valve supervisory (tamper) switch as part of the valve assembly.

2.07 PRE-ACTION & DELUGE VALIVES

A. Pre-action assembly and/or deluge valve shall be of an iron body, bronze trimmed, listed for a maximum working pressure of 175 psi, hydraulically

operated, differential pressure type valve. Deluge valve and associated equipment shall be manufactured by Viking, TotalPac system.

B. Valve shall be complete with trim, drain, releasing (solenoid switch), and all accessories and apparatuses necessary for proper operation. Provide pilot line trim and emergency pull box as follows:

1. Dual (Double Interlocked) Release System: Galvanized trim piping set includes air and water gauges low air supervisory switch, air relief valve, solenoid switch, pneumatic actuator with threaded water and air inlets and water outlets. The solenoid switch and air supervisory switch shall be crossed zoned in accordance with the manufacturer's requirements. The system requires both and electric and pneumatic release to cause the deluge/pre-action valve to open.

C. Emergency Pull Box: Metal enclosure labeled “IN CASE OF FIRE OPEN DOOR AND PULL LEVER” and operating instructions, complete with union ½ inch pipe nipple, and bronze ball valve.

2.08 INSPECTOR'S TEST CONNECTION

A. Provide wet-type inspector's test assembly for each wet-pipe sprinkler system. Inspector’s test valves shall be located approximately 6 feet above the floor, at the system riser. Inspector's test assembly shall be manufactured by AGF test and drain.

B. All pipe and fittings downstream of inspector's test valves shall be galvanized.

2.09 DRAINS

A. Provide system main drain with valve to discharge to the outside. For trapped sections of pipe, provide auxiliary drain valve with nipple and cap or plug. Valves to have rubber seat disc and threaded ends, or acceptable equal.

B. For trapped pipe with less than 5-gallon capacity, provide nipple and cap or plug.

2.10 PIPE SLEEVES & FIRE STOPPING

A. Provide pipe sleeves of sufficient length to pass through the entire thickness of floor or wall. Provide clearance between exterior of piping and interior of sleeves in accordance with NFPA 13. Firmly pack space with noncombustible insulation. Caulk both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a segmented elastomeric seal to maintain the fire resistance rating.

B. Fire stopping shall be applied at penetrations through fire rated walls and/or floors with a durable, UL-listed firestop assembly, restoring the original fire

resistance and integrity of the wall and/or floor penetrated. Fire stopping material shall be manufactured by 3M or Hilti.

2.11 FIRE DEPARTMENT CONNECTIONS

A. The fire department connection shall be properly secured to the system piping with necessary check valve and ball drip drain. Provide 4-inch flush type "Storz" quick connect fire department connections. Storz cap shall be securely attached to the building structure by means of plastic coded cable or corrosion resilient chain.

B. Fire department connection piping downstream of check valve shall be ductile iron. Provide a 22 degree (female and male) straight elbow on exterior inlet pipe to Storz connection and remove gasket from Storz cap. Storz connection shall be properly labeled as "FIRE DEPARTMENT CONNECTION".

2.12 WATERFLOW DETECTORS

A. Vane type waterflow detectors for wet-pipe systems shall have an instantly recycling adjustable retard set to provide 30-60 seconds delay. Waterflow detectors shall be provided with double pole, double throw contacts, rated at 120 VAC, 3 amps, minimum. Vane type waterflow detectors shall be manufactured by Potter or System Sensor.

B. Pressure type waterflow alarm switch for dry pipe type systems shall have a circuit opener or closer for the automatic transmission of a waterflow alarm over the facility fire alarm system. Waterflow alarm actuating device shall be of the mechanical diaphragm, controlled water pressure type, without retard device. Waterflow alarm shall instantly recycle upon pressure release of the diaphragm. Pressure waterflow detectors shall be manufactured by Systems Sensor, EPS Series.

2.13 VALVE SUPERVISORY SWITCHES:

A. Valve supervisory (tamper) switches shall be provided on all OS&Y sprinkler system control valves, and shall be manufactured by System Sensor or Potter.

2.14 AUTOMATIC SPRINKLERS:

A. Subcontractor shall install sprinklers of proper temperature ratings. Sprinklers shall have an ordinary temperature rating (165°F) or higher as suitable for the specific application as governed by NFPA 13.

1. Sprinklers in Detector Hall shall be sidewall, extended coverage, K-factor of 11.2, Tyco Model SW-20, see drawings for additional information.

2. Sprinklers in Experimental/Detector Hall shall be upright-type, quick-response with nominal 3/4" NPT, K-factor of 8.0, 200°F temperature rating, Viking Microfast.

3. Sprinklers in remaining exposed areas shall be upright-type, quick-response with nominal ½" NPT, K-factor of 5.6, 155°F temperature rating, Viking Microfast.

4. Sprinklers in finished areas shall be pendent-type, concealed, quick-response with nominal ½" NPT, K-factor of 5.6, 155°F temperature rating, Viking Horizon.

5. Sprinkler guards shall be provided on sprinklers within 7 feet of the finished floor or wherever sprinklers may be subject to mechanical damage.

2.15 SPARE SPRINKLERS:

A. Provide one (1) metal sprinkler cabinet containing a minimum of twelve (12) extra sprinklers and two (2) sprinkler wrenches, as directed by the Fermilab Construction Coordinator.

2.16 AIR COMPRESSOR

A. An automatic type electric motor driven air compressor, including pressure switch and air piping.

B. Compressor shall be capable of charging the entire system to normal system air pressure within 30 minutes.

C. Provide the system with an automatic air pressure maintenance device. System shall have shut-off valves to permit servicing without shutting down the sprinkler system, bypass valve for quick system filling, and strainer. Electrical ratings shall match compressor ratings.

2.17 LOW AIR PRESSURE SUPERVISORY SWITCH

A. Low air pressure supervisory switch shall be provided for the dry pipe and pre-action sprinkler systems.

B. Alarm shall give a signal when air pressure in the system drops to a point halfway from the normal pressure to the tripping point.

C Provide contact to interface with the fire alarm panel

PART 3 INSTALLATION

3.01 COORDINATION WITH OTHER TRADES

A. Coordinate all work under this section with all related work as applicable and as indicated elsewhere in the project documents.

B. Failure to properly coordinate with related trades and related work, including Section 16721, shall be corrected as part of this work at no extra cost to Fermilab.

3.02 WELDING

A. Welding methods shall comply with all the requirements of AWS D10.9 and ANSI B 31.10b. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler systems, except if approval is granted from the Construction Coordinator and a "Burn Permit" is issued.

B. Certify welders and brazers as being qualified for welding and/or brazing in accordance with the requirements of AWS D10.9, Level AR-3.

3.03 INSTALLATION: The Subcontractor shall notify the Fermilab Construction Coordinator a minimum of forty-eight (48) hours before start of work.

A. All equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with NFPA 13, except as modified herein.

B. Inspect piping before placing into position. Install piping straight and true to bear evenly on hangers and supports. Keep the interior and ends of piping thoroughly cleaned of debris and foreign matter.

C. Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position.

D. All holes made by Subcontractor in any wall, ceiling, or floor shall be patched by the Subcontractor, restoring the wall, ceiling, or floor to its original condition, fire resistance and integrity.

3.04 FIELD PAINTING

A. Clean, pretreat, prime, and paint unpainted components of the new fire sprinkler systems (except sprinklers) including valves, fittings, piping, and other components. Clean the surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat of oil based primer and one coat red gloss or semi-gloss paints. Galvanized piping and fittings do not require painting.

B. Primer and finished paint to be equal to the oil based products as manufactured by Glidden Company. Apply coatings to clean, dry surfaces, using clean brushes. Provide "touch-up" painting as needed upon completion of installation.

3.05 GUARANTEE:

A. The Subcontractor shall, as a condition precedent to final payment, execute a written guaranty to Fermilab warranting all materials and equipment furnished by them under this contract to remain in satisfactory operating condition for a period of one year from the date of final acceptance of the work by Fermilab. All defects or damage due to faulty materials or workmanship shall be repaired or replaced without delay at the Subcontractor's expense and to Fermilab's satisfaction.

3.06 PRESSURE TEST

A. Fermilab will witness all tests for all systems before final acceptance. Submit the request for inspection at least 48 hours prior to the testing date. An experienced technician regularly employed by the system installer, shall be present during the testing. Furnish all appliances, equipment, instruments, connecting devices, and personnel for conducting the tests. Hydrostatically pressure test the system at test pressure for a 2-hour period with no leakage or reduction in gauge pressure. Test pressure shall be 200 psig. Correct any defects if found in work and conduct additional tests until the system complies with all contract requirements.

B. After successful hydrostatic testing, test the waterflow alarms by flowing water through the inspector's test station. Flush piping with water used for the hydrostatic test in accordance with NFPA 13.

3.07 FINAL ACCEPTANCE TEST

A. Notify the Fermilab Construction Coordinator at least 48 hours in advance of the completion of each system.

B. The installing Subcontractor or Subcontractors and/or the equipment manufacturer's representative shall perform a complete functional test of the sprinkler systems. This will include operation of valve supervisory (tamper) switches and waterflow detectors.

C. This test is to be witnessed by the Fermilab Construction Coordinator, Fire Department, Fire Protection Engineer, Fire System Maintenance, Building Manager, and Safety Department prior to approval. Repeat any or all of the required tests as directed.

D. Correct any defects in work provided by the Subcontractor and conduct additional tests until the systems comply with all contract requirements.

3.08 TEST REPORTS:

A. When all tests are completed and all corrections made, submit a signed and dated certificate, identical to that specified in NFPA 13 for each system. Submit six (6) copies of the completed forms.

END OF SECTION 15300

SECTION 15416 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.02 SUMMARY

A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to but no fewer than one of each type.

PART 2 - PRODUCTS

2.01 WALL-MOUNTED WATER CLOSETS

A. Water Closets: Floor mounted, top spud.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. American Standard America.
   b. Crane Plumbing, L.L.C.
   c. Kohler Co.
   d. TOTO USA, INC.
2. Bowl:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.

e. Height: Accessible.
f. Rim Contour: Elongated.
g. Spud Size and Location: NPS 1-1/2 (DN 40); top.

3. Flushometer Valve: Sensor Battery; Piston.
4. Toilet Seat: Elongated open front.
5. Support:
   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.
   c. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1.

2.02 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. American Standard America.
   b. Bemis Manufacturing Company.
   c. Centoco Manufacturing Corporation.
   d. Church Seats.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install accessible, floor-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

C. Install toilet seats on water closets.

D. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Division 7 Section "Joint Sealants."

3.03 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Division 15 Section "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Division 15 Section "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.04 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 15416

SECTION 15421 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Lavatories.
2. Faucets.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Appendix A include the following:
   a. Servicing and adjustments of automatic faucets.

1.04 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.01 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory: Vitreous china, wall mounted, with back.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. American Standard.
   b. Crane Plumbing, L.L.C.
   c. Kohler Co.

2. Fixture:
   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: For wall hanging.
   c. Nominal Size: 21 by 18 inches.
   d. Faucet-Hole Location: Top.
   e. Color: White.
   f. Mounting Material: Chair carrier.

3. Faucet: wrist blade, deck mounted. Chrome plated brass

4. Faucet manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Chicago Facuet.
   b. Zurn,
   c. Moen.
   d. T&S Brass

5. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.

2.02 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

2.03 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32).
2. Material: Chrome-plated 17 gauge, two-piece, cast-brass trap and swivel elbow with brass tube to wall; and chrome-plated, brass or steel wall flange.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine walls for suitable conditions where lavatories will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 7 Section "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Division 15 Section "Plumbing Piping Insulation."

3.03 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Division 15 Section "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Division 15 Section "Sanitary Waste and Vent Piping."

3.04 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 15421

SECTION 15427 - ELECTRIC WATER COOLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes electric water coolers and related components.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of electric water cooler.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.03 CLOSEOUT SUBMITTALS

A. Maintenance Data: For electric water coolers to include in maintenance manuals.

1.04 QUALITY ASSURANCE

A. Comply with Public Law 111-380, the Reduction of Lead in Drinking Water Act.

PART 2 - PRODUCTS

2.01 ELECTRIC WATER COOLERS

A. Electric Water Coolers EWC-1: Flush to wall.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
   a. Elkay Manufacturing Co.
   b. Halsey Taylor.
   c. Haws Corporation.
   d. Larco Inc.
   e. Tri Palm International, LLC; Oasis Brand.
   f. Tri Palm International, LLC; Sunroc Brand.
2. Standards:
   a. Comply with NSF 61.
   b. Comply with ASHRAE 34, “Designation and Safety Classification of Refrigerants,” for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

3. Cabinet: Vinyl-covered steel with stainless-steel top.

4. Bubbler: One, with adjustable stream regulator, located on deck.
5. Control: Push button.
6. Drain: Grid with NPS 1-1/4 (DN 32) tailpiece.
7. Supply: NPS 3/8 (DN 10) with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.
9. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards, with capacity sized for unit peak flow rate.
10. Cooling System: Electric, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Capacities and Characteristics:
    a. Cooled Water: 8 gph (0.0084 L/s).
    b. Ambient-Air Temperature: 70 deg F (32 deg C).
    c. Inlet-Water Temperature: 80 deg F (27 deg C).
    d. Cooled-Water Temperature: 50 deg F (10 deg C).
    e. Electrical Characteristics:
        1) Volts: 120-V ac.
        2) Phase: Single.
        3) Hertz: 60.
        4) Full-Load Amperes: 4.

3.01 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set freestanding electric water coolers on floor.

C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

D. Install mounting frames, affixed to building construction, and attach recessed, electric water coolers to mounting frames.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 15111 “General-Duty Valves for Plumbing Piping.”

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 15097 “Escutcheons for Plumbing Piping.”

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07920 “Joint Sealants.”

3.03 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 15140 “Domestic Water Piping.”

C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 15111 “General-Duty Valves for Plumbing Piping.”

D. Comply with soil and waste piping requirements specified in Section 15150 “Sanitary Waste and Vent Piping.”

3.04 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust electric water-cooler temperature settings.

3.05 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer’s written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15427

1.01 SECTION 15445 - SEWAGE PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Submersible sewage pumps.

B. Related Sections include the following:

1. Section 02532 “Packaged Sewage Pumping Stations” for applications in site-construction sewage pumping.
2. Section 15446 “Sump Pumps” for applications in storm-drainage systems.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.06 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.01 SUBMERSIBLE SEWAGE PUMPS

A. Submersible, Fixed-Position, Double-Seal Sewage Pumps EP-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. ABS Pumps Inc.
   b. Barnes; Crane Pumps & Systems.
   c. Bell & Gossett Domestic Pump; ITT Corporation.
   d. BJM Pumps, LLC.
   e. Chicago Pump Company; a division of Yeomans Chicago Corporation.
   f. EBARA Fluid Handling.
   g. E.I.M. Electric Co., Ltd.
   h. Federal Pump Corp.
   i. Goulds Pumps; ITT Corporation.
   j. HOMA Pump Technology Inc.
   k. ITT Flygt Corporation.
   l. KSB Inc.
   m. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
   n. Pentair Pump Group; Fairbanks Morse.
   o. Pentair Pump Group; Hydromatic Pumps.
   p. Pentair Pump Group; Myers.
   q. PX Pumps USA.
   r. Stancor, Inc.
   s. Sta-Rite Industries, Inc.
   t. Swaby Manufacturing Company.
   u. Weil Pump Company, Inc.
   v. Weinman Division; Crane Pumps & Systems.
   w. WILO-EMU USA LLC.
   x. Zoeller Company.
2. Description: Factory-assembled and -tested sewage-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor,

waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: Air.

10. Controls:

a. Enclosure: NEMA 250, Type 1
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:
a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
1) On-off status of pump.
2) Alarm status.

2.02 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15057 “Common Motor Requirements for Plumbing Equipment.”

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.02 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.
2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

C. Wiring Method: Comply with requirements in Section 16120 “Conductors and Cables.”

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 CONNECTIONS

A. Comply with requirements for piping specified in Section 15150 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 15445

SECTION 15446 - SUMP PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sump-pump basins and basin covers.
2. Packaged drainage-pump units.

B. Related Section:

1. Section 15445 “Sewage Pumps” for effluent and sewage pumps.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 PRODUCTS

2.01 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Fiberglass.
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

2.02 PACKAGED DRAINAGE-PUMP UNITS

A. Packaged Pedestal Drainage-Pump Unit, SP-1 & SP-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. AMT; a subsidiary of the Gorman-Rupp Company.
   b. Goulds Pumps; ITT Corporation.
   c. Liberty Pumps.
   d. WEIL
   e. Homa Pump.
   f. Scot Pump.
   g. Zoeller Company.
2. Provide and install Weil Pump Co. duplex pump system, including (2) Weil Pump Model 2400-DS heavy duty. 3” discharge submersible wastewater ejector pumps capable of passing 2” solids. Pumps shall be constructed with carbon-ceramic mechanical seal, cast iron impeller. Pumps shall be provided as a packaged system. Pumps, controls and accessories shall be supplied by one source to maintain consistency and uniformity of the system
3. Control Panel shall be Weil Pump Series 8100 NEMA-4 duplex, UL Listed, with a main disconnect, transformer, starters, O.L. blocks, H-O-A switches, run light and alarm horn and light with silence push-button, and dry remote alarm contacts. Control panels with printed circuit boards shall not be allowed or considered equal. Float control shall be, (4) Weil Pump Model 8200 submersible float switches to control pump “off”, “on”, “lag”, and “high water alarm” level
4. Pump basin shall be fiberglass with glassed in removal system anchor studs in basin bottom, contractor to provide and install Weil Pump Co. Model 2613-3 quick removal systems, each with base elbow, iron yoke, upper guide pipe brackets with bosses (guide pipes by contractor), and 3" discharge flange kit
5. Basin Cover Duplex heavy duty steel, 3/8” think minimum with epoxy coating, pump basin cover including pump removal door(s), discharge flanges, float control opening, cable slots, vent flange and inspection opening. Contractor shall furnish Weil Pump Co. Model 2616-3 Duplex valve assembly constructed of heavy duty ASTM-A-

48 Class 30 cast Iron, including (2) angle check valves and (1) 4 - position isolation valve on discharge line

2.03 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15057 “Common Motor Requirements for Plumbing Equipment.”

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 EXECUTION

3.01 EARTHWORK

A. Excavation and filling are specified in Section 02300 “Earthwork.”

3.02 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.03 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.04 CONNECTIONS

A. Comply with requirements for piping specified in Section 15160 “Storm Drainage Piping.” Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.05 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 15446

SECTION 15485 - ELECTRIC WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Commercial, electric, storage, domestic-water heaters.

2. Domestic-water heater accessories.

1.02 SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittal:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."

C. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

D. Product Certificates: For each type of, electric, domestic-water heater, from manufacturer.

E. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

F. Source quality-control reports.

G. Field quality-control reports.

H. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

I. Warranty: Sample of special warranty.

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.05 COORDINATION

A. Coordinate wall mounting with structure and other trades.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Electric, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.

2) Controls and Other Components: Five years.

PART 2 - PRODUCTS

2.01 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Bradford White Corporation.

b. Lochinvar Corporation.

c. PVI Industries, LLC.

d. Rheem Manufacturing Company.

e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.

2. Standard: UL 1453.

3. Storage-Tank Construction: ASME-code, steel vertical arrangement.

a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

b. Pressure Rating: 150 psig (1035 kPa).

c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.

b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

c. Insulation: Comply with ASHRAE/IESNA 90.1.

d. Jacket: Steel with enameled finish.

e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.

f. Temperature Control: Adjustable thermostat.

g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.

h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Special Requirements: NSF 5 construction.

2.02 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. AMTROL Inc.

   b. Watts.

   c. Taco.

   d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.

   e. State Industries.

2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm, suitable for potable water. Include air precharge to minimum system-operating pressure at tank.

3. Construction:

   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

   c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics:

   a. Refer to Schedule on Drawings.

B. Combination Support and Drain Pan: Corrosion-resistant 18 gauge galvanized steel with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE 90.2.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure

rating. Select relief valves with sensing element that extends into storage tank.

F. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.

G. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

2.03 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Appendix A for retesting and reinspecting requirements and for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."

1. Maintain manufacturer's recommended clearances.

2. Arrange units so controls and devices that require servicing are accessible.

3. Support raised pan platform from structure as required by pan manufacturer.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 15 Section "General-Duty Valves for Plumbing Piping."

C. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Comply with requirements for hose-end drain valves specified in Division 15 Section "Domestic Water Piping Specialties."

E. Install thermometers on inlet and outlet piping of electric, domestic-water heaters.

F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

G. Fill electric, domestic-water heaters with water.

H. Charge domestic-water compression tanks with air.

3.02 CONNECTIONS

A. Comply with requirements for piping specified in Division 15 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 15 Section "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Appendix A for retesting and reinspecting requirements and for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain , electric, domestic-water heaters.

END OF SECTION 15485

SECTION 15561 - AIR HANDLING UNITS

PART 1 - GENERAL

1.01 WORK INCLUDES

A. Provide four (4) air handling units with gas fired heating sections, chilled water coils cooling, controls package with sensors and accessories as scheduled on drawings.

B. Provide one (1) computer room air handling (CRAH) unit with electric heat, chilled water cooling coil, humidifier and all controls and accessories.

1.02 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each unit indicated.

B. Shop Drawings: Details of equipment assembly and mounting:

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and maintenance data.

1.03 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each unit.
2. Fan Belts: One set for each unit.
3. Provide fixed pitch pulleys for belt driven fans. Provide replacement pulley sized by balancing contractor to achieve design airflows.

1.04 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, “Safety Code for Mechanical Refrigeration”.

B. EER – equal to or greater than prescribed by ASHRAE 90.1.

C. Certified in Accordance with UL Standard 1995 and ANSI Z21.47.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air handling units that fail in materials or workmanship within two (2) years from date of Final Inspection/Acceptance. See notes on drawing for extended warranty on specific components.

B. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five (5) years from date of final acceptance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: For computer room air handling units, subject to compliance with requirements, provide products by one (1) of the following:

1. Liebert.

B. Manufacturers: For variable air volume air handling units, subject to compliance with requirements, provide products by one (1) of the following:

1. York.
2. Trane.
3. McQuay.

C. Manufacturers: For gas fired duct furnaces, subject to compliance with requirements, provide products by one (1) of the following:

1. Modine Manufacturing Company.
2. Reznor/Thomas & Betts.
3. Sterling HVAC Products.
4. Titan Air Incorporated.
5. Trane.

2.02 AHU-3 COMPUTER ROOM AIR HANDLING (CRAH) UNIT

A. General

The computer room environmental control system shall be self-contained factory assembled unit with up-flow air delivery.

B. Cabinet and Frame Construction

The frame shall be constructed of heliarc welded tubular steel. Unit shall be painted using the autophoretic coating process for maximum corrosion protection. The exterior panels shall be insulated with a minimum 1 inch, 1.5 lb. density fiber insulation. The main front panel shall have captive 1/4 turn fasteners. The unit color shall be selected by the FNAL architect.

C. Filter Chamber

The filter chambers shall be an integral part of the system, located within the cabinet serviceable from either end of the unit. The filters shall be rated not less than 30% efficiency (based on ASHRAE 52.1).

D. Fan Section

The fans are plug/plenum type, single inlet and shall be dynamically balanced. The drive pack-age shall be direct drive, electronically commutated and variable speed. Fans will be located above the unit. The fans shall be located to draw air over the A-frame coil

E. Microprocessor Control / Graphic Display

1. Internal unit component control shall include the following:
   a. System Auto Restart - The auto restart feature will automatically restart the system after a power failure. Time delay is programmable.
   b. Sequential Load Activation - On initial startup or restart after power failure, each operational load is sequenced with a minimum of one second delay to minimize total inrush current.
   c. Predictive Humidity Control - calculates the moisture content in the room and prevents unnecessary humidification and dehumidification cycles by responding to changes in dew point temperature.
2. The control shall be BACnet IP, compatible with remote monitoring and control devices and interface with the existing Metasys BAS.
3. Graphic display & housing shall be viewable while the unit panels are open or closed. The controls shall be menu driven. The system shall display menus for: active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in % of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make system changes within the service menus.
4. Service menus shall include: setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode. Service menu shall allow setpoints within the following ranges:
   a. Temperature Setpoint 65-85ºF (18-29ºC)*
   b. Temperature Sensitivity +1-10ºF (0.6-5.6ºC)
   c. Humidity Setpoint 20-80% RH*
   d. Humidity Sensitivity 1-30% RH
   e. High Temperature Alarm 35-90ºF (2-32ºC)
   f. Low Temperature Alarm 35-90ºF (2-32ºC)
   g. High Humidity Alarm 15-85% RH
   h. Low Humidity Alarm 15-85% RH
5. Menu shall allow customer settings for alarm notification (audible/local/remote). The following alarms shall be available:
   a. High Temperature
   b. Low Temperature
   c. High Humidity

d. Low Humidity
e. Main Fan Overload (Optional)
f. Humidifier Problem
g. Change Filter
h. Fan Failure
i. Unit Off

F. Chilled Water Control Valve

The water circuit shall include a 2-way modulating valve. The unit's controls will position the valve in response to room conditions.

G. A-Frame Chilled Water Coil

1. The cooling coil shall be of A-frame design
2. The coil shall be controlled by a 2-way modulating control valve. It shall be constructed of copper tubes and aluminum fins and have a maximum face velocity of 500 feet per minute.
3. The water circuit shall be designed to distribute water into the entire coil face area. The entire coil assembly shall be mounted in a stainless steel condensate drain pan.

H. Infrared Humidifier

1. The humidifier shall be of the infrared type consisting of high intensity quartz lamps mounted above and out of the water supply.
2. The evaporator pan shall be stainless steel and arranged to be serviceable without disconnecting high voltage electrical connections.
3. The compete humidifier section shall be pre-piped ready for final connection. The infrared humidification system shall use bypass air to prevent over-humidification of the computer room.
4. The humidifier shall be equipped with an automatic water supply system. The system has an adjustable water-overfeed to prevent mineral precipitation.

I. Flow Switch

The flow switch shall activate the alarm system should the chilled water supply be interrupted. The switch shall be factory mounted and wired.

J. Disconnect Switch – Locking Type

Manual disconnect switch shall be mounted in the high voltage section of the electrical panel. The switch shall be accessible from the outside of the unit with the door closed, and prevent access to the high voltage electrical components until switched to the "OFF" position.

K. Smoke Sensor

Smoke sensor shall shut down the environmental control system and activate the alarm system when activated. The smoke sensor shall be mounted in the electrical panel with the sensing element in the return air compartment.

2.03 AHU-1, 2, 4 & 5 VARIABLE VOLUME AIR HANDLING UNITS

A. General Description

1. Unit will be complete with fans, motors, coils, dampers, controls, access doors and other components/options, as shown on product drawings, wiring diagrams, and as described in performance specifications.
2. Fans and drives will be balanced to limit vibration at operating speeds.
3. Unit will ship in one (1) piece whenever possible. Shipping splits will be provided when necessary. Lifting lugs will be provided where required for proper lifting.
4. Unit casing will be factory insulated.
5. Units will be ETL labeled.

B. Unit Casing

1. Unit shall be specifically designed for indoor applications.
2. Unit casing will consist of a structural frame and insulated roof, wall, and floor panels.
3. Removal of wall panels will not affect structural integrity of units.
4. Unit casing will be insulated with spray injected foam to achieve a minimum thermal resistance of R13 hr-ft2-°F/BTU. Insulation application will meet the requirements of NFPA 90A
5. Insulation system will be resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338
6. Unit will conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections.
7. Wall panels and access doors will deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. ‘L’ is the panel-span length and ‘L/240’ is the deflection at panel midpoint.
8. Unit will have double wall, 2” insulated panels for walls, roof, and floor. Exterior skin will be galvanized sheet steel. Individual segments will have galvanized sheet steel interior liner.
9. Floor panels will be double wall construction, designed to provide at most L/240 deflection when subjected to a 300 lb. load at mid-span.
10. Double wall access doors will be provided on sections as shown on product drawings.

a. Access door will be of the same material type as exterior/interior casing.

11. View ports will be double-pane tempered glass.

C. Drain Pans

1. Drain pans comply with the guidelines of ASHRAE 62.
   a. Drain pans will be double sloped at least 1/8" per foot, and have no horizontal surfaces.
   b. Drain connection material will be the same as drain pan.
   c. Drain pans drain to one point.
   d. Drain connections will be welded to drain pans
   e. Drain pans will have at least 1" clearance between pan and coil supports.

D. Fans

1. Fans will provide CFM and static pressure, as shown in performance specifications.
2. Fans will be Class I, II, or III, as required to meet selected RPM and horsepower shown in performance specifications.
3. Fans will be DWDI as shown on product drawings.
4. Fans will have airfoil blades, as shown in performance specifications.
5. Airfoil fans will bear the AMCA Seal. Airfoil fan performance will be based on tests in accordance with AMCA standard 210 and will comply with the requirements of AMCA certified ratings programs for air and sound. Airfoil wheels will comply with AMCA standards 99 2408 69 and 99 2401 82.
6. Fans shafts will be polished steel and sized such that the first critical speed will be at least 125% of the maximum operating speed for the fan pressure class. Shaft will be coated with an anti-corrosion coating.
7. Fan and motor assembly will be internally mounted on a common base. Fan and motor base will be spring isolated on a full width isolator support channel.
   a. Fan motor will be on an adjustable base.
   b. Fan discharge will be connected to cabinet via a flexible connection.
   c. Access doors will be provided as shown on product drawing.

E. Bearings and Drives

1. Fan bearings will have average life (L50) of at least 200,000 hours. Bearing fatigue life ratings will comply with ANSI/AFBMA 9.
2. Regreaseable fan bearings will be factory lubricated and equipped with standard hydraulic grease fittings and lube lines extended to the motor side of the fan. Fan drives will be selected for a 1.5 service factor and will be furnished with anti-static belts.
   a. Drives will be fixed pitch.

b. Sheaves will be machined from close grain cast iron and statically balanced.
c. Drive belts will be V type, precision molded, raw edge construction, anti-static, oil and heat resistant.

F. Electrical Motors

1. Fan motors will be built in accordance with the latest NEMA and IEEE standards.
2. Fan motors comply with ASHRAE Standard 90.1.
3. Fan motors will be furnished in sizes, electrical power and starting characteristics as shown in performance specifications.
4. Fan motors will be rated for continuous, full load duty at 104° F (40° C) ambient temperature and 1.15 service factor.
5. Fan motors will be NEMA design ball bearing type.
6. Fan motors will be Open drip proof (ODP)
7. Motors will be suitable for use with variable frequency drives, per NEMA MG-1 Part 30.

G. Fan Variable Frequency Drives

1. Variable frequency drives will be provided factory mounted and wired to motor with units.
2. VFDs will be UL or ETL listed and comply with applicable provisions of the National Electric Code.
3. VFDs will be housed in a dedicated, weather resistant compartment.
4. VFD will include harmonic distortion feedback protection
5. User interface display data includes:
   a. output frequency (Hz)
   b. speed (RPM)
   c. motor current
   d. calculated % motor torque
   e. calculated motor power (kW)
   f. DC bus voltage
   g. output voltage
   h. heat sink temperature
   i. elapsed time meter (re-settable)
   j. kWh (re-settable)
   k. input / output terminal monitor
   l. PID actual value (feedback) & error
   m. fault text
   n. warning text
   o. scalable process variable display

6. VFD protection circuits will include:
   a. over current
   b. ground fault
   c. over voltage

d. under voltage
e. over temperature
f. input power loss of phase
g. loss of reference/feedback
h. adjustable current limit regulator

7. VFD will be UL 508C approved for electronic motor overload (12t).
8. VFD will include high input transient protection and surge suppression.

H. Manufactured Cooling Coils

1. Water, coil capacity and pressure drop performance will be certified in accordance with AHRI Standard 410, when selected within fluid velocity, inlet fluid temperature, and entering air temperature ranges specified by AHRI 410.
2. Cooling coil segments will have a full-width IAQ drain pan that extends at least 6” downstream of the last coil in the section.
3. Coils will be removable from the side of unit, via removable AHU panels. No more than one panel must be removed to remove a coil.
4. Coils will have frames constructed of galvanized steel. Casing channels will be free-draining and do not block fin area.
5. Coil segment door clearances will allow for at least 2-inches of field installed piping insulation.
6. Coil bulkheads and blank-offs will prevent air from bypassing coils.
7. Coil segment casing to accommodate full-face or reduced-face coils will be provided. Provide face and bypass coil segments with factory installed bypass damper
8. A 1/4" FPT plugged vent/drain tap will be provided on each connection. Vent, drain, and coil connections will be extended to outside of AHU casing.
9. Staggered Coil bank will be provided. A 1/4" FPT plugged vent/drain tap will be provided on each connection. Vent, drain, and coil connections will be supplied within 10” of the header.
10. Spool shaped coil grommets will be provided to insulate and seal coil penetrations.
11. Water and glycol coils will be designed to operate at 250 psig and up to 300° F and will be factory tested with 325 psig compressed air under water.
12. Glycol coils tubes will be mandrel expanded to form fin bond and burnished, work-hardened interior surface.
13. Coil fins will be die-formed, continuous aluminum and have fully drawn collars to accurately space fins, and form a protective sheath for tubes.

I. Filters

1. Filter segments will be provided with filter tracks/frames an integral part of the unit.

2. Filter types, nominal sizes, efficiencies, and performance characteristics as scheduled.
3. Filter access will be provided via access doors on filter segments or adjacent segments as required by filter loading scheme.
4. Factory installed differential pressure gauge on the drive side of unit to measure pressure drop across filters will be provided.

2.04 GAS-FIRED DUCT FURNACE

1. General:
   a. Indirect Fired Duct Furnace. The unit shall be factory fabricated, assembled, wired and tested prior to shipment in accordance with the specification and equipment schedule.
   b. The unit will include all components herein and as shown on the drawings. The unit shall be ETL listed.
2. Casing
   a. The unit casing shall be panel construction galvanized steel, reinforced to ensure rigidity.
   b. The casing enclosing the heat exchanger shall be of double wall construction with a galvanized steel inner wall serving as a radiation shield.
   c. This section shall be insulated with 1", 1.5 lb. density insulation.
3. Indirect Gas-Fired Section:
   a. The heat transfer surface and header shall be of aluminized steel construction. The heat exchanger design shall permit unrestricted lateral and peripheral expansion during the heating and cooling cycle.
   b. The heat exchanger shall be rated at a minimum of 80% efficiency at rated out-put.
4. Direct Drive Induced Draft Fan:
   a. An integrally mounted, heavy duty, non-clogging radial blade induced draft fan complete with direct drive motor shall be provided. The induced draft fan shall be adequately sized to insure proper draft conditions when operating at rated capacity and equipped with a manual damper complete with locking quadrant to ensure proper draft and extended heat exchanger performance.
5. Burner:
   a. Burner and controls shall be capable of delivering scheduled MBH output firing on natural gas at an inlet pressure of 5 to 14 inches water column, in accordance with FM requirements. Burner and controls shall be arranged for Full Modulation with low fire start and up to a 4:1 turndown ratio.
   b. The factory wired and piped valve train shall be mounted inside the unit weatherproof enclosure and be complete with:
      1) Low pressure appliance regulator
      2) Motorized gas control valve
      3) Main manual test firing shut-off valve

4) Pilot manual shut-off valve
5) Pilot pressure regulator
6) Pilot automatic shut-off valve
7) Pilot manual test firing shut-off valve

6. Electrical Controls:
   a. All control components are to be labeled and individually wired to a numbered terminal strip to aid in servicing.
   b. All wiring shall be color coded and number tagged at each end to match the control diagram supplied.
   c. Full operating and maintenance instructions shall accompany each unit.
   d. All electrical components shall bear the U.L. label. The control system shall include but not be limited to the following components required for automatic operation:
      1) Control circuit transformer
      2) Control circuit fuses
      3) Control relays
      4) Electronic flame relay complete with alarm contacts
      5) Induced draft fan air proving differential switch
      6) High limit switch
      7) Automatic/manual fan switch
      8) Heavy duty ignition transformer

B. Finishes

1. External unit surfaces will be factory cleaned prior to finishing or shipping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

3.02 UNIT START UP & COMMISSIONING

A. Provide Factory Authorized Service and Startup serviceman for final check of installation and equipment. The units shall be serviced and started. Provide written certification that the unit is installed and operating correctly.

B. Provide Owner's personnel a minimum of four (4) hours of training on the operation and maintenance of the units.

END OF SECTION 15561

SECTION 15564 - INDOOR, INDIRECT, GAS-FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes indirect, gas-fired heating and ventilating units.

1.2 DEFINITIONS

A. BAS: Building automation system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and configuration of indoor, indirect, gas-fired heating and ventilating unit.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type and configuration of indoor, indirect, gas-fired heating and ventilating unit.
1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Startup service reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect-fired heating and ventilating units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each unit.

2. Fan Belts: One set for each unit.
3. Provide fixed pitch pulleys for belt driven fans. Provide replacement pulley sized by balancing contractor to achieve design airflows.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Modine Manufacturing Company.
2. Reznor/Thomas & Betts.
3. Sterling HVAC Products.
4. Titan Air Incorporated.
5. Trane.

2.2 SYSTEM DESCRIPTION

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters,and indirect-fired gas burner to be installed inside the building.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
3. Casing Coating: Hot-dip galvanized.
4. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Configuration: Horizontal unit with horizontal discharge for floor-mounted installation.

C. Cabinet: Galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Duct flanges at inlet and outlet.
1. Double-wall casing with inner wall of solid steel.

2. Internal Insulation: Fibrous-glass duct lining, neoprene coated, comply with ASTM C 1071, Type II, applied on complete unit.
a. Insulation Adhesive: Comply with ASTM C 916, Type I.

2.4 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel.

B. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

C. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

2.5 AIR FILTERS

A. Comply with NFPA 90A.

B. Disposable Panel Filters: Factory-fabricated, pleated-type, disposable air filters with holding frames, with a MERV 7 according to ASHRAE 52.2].

1. Thickness: 2 inches (50 mm).
2. Frame: Galvanized steel.

2.6 INDIRECT-FIRED GAS BURNER

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and with NFPA 54, "National Fuel Gas Code."

1. CSA Approval: Designed and certified by and bearing label of CSA.
2. Burners: Stainless steel.

    a. Gas Control Valve: Two stages per furnace section, four stages minimum for unit.
    b. Fuel: Natural gas.
    c. Minimum Combustion Efficiency: 80 percent.
    d. Ignition: Electronically controlled electric spark with flame sensor.

B. Venting: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.

C. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.

D. Heat Exchanger: Stainless steel.

E. Safety Controls:

1. Vent Flow Verification.
2. Control Transformer: 24-V ac.
3. High Limit: Thermal switch or fuse to stop burner.
4. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
6. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
7. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
8. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.7 CONTROLS

A. Comply with requirements in Section 15900 "HVAC Instrumentation and Controls" and Section 15940 "Sequence of Operation" for control equipment and sequence of operation.

2.8 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 15058 "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of indirect-fired heating and ventilating units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install heating and ventilating units on cast-in-place concrete equipment bases.

B. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

C. Install controls and equipment shipped by manufacturer for field installation with indirect-fired heating and ventilating units.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service.

B. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

C. Duct Connections: Connect supply and outside air ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 15820 "Duct Accessories" for flexible duct connectors.

D. Ground equipment according to Section 16060 "Grounding and Bonding."

E. Connect wiring according to Section 16120 "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
2. Inspect for visible damage to burner combustion chamber.
3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.

    a. Verify that filters are installed.
    b. Purge gas line.
    c. Verify bearing lubrication.
    d. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
    e. Adjust fan belts to proper alignment and tension.
    f. Start unit according to manufacturer's written instructions.

6. Complete startup sheets and attach copy with Contractor's startup report.
7. Inspect and record performance of interlocks and protective devices; verify sequences.
8. Operate unit for run-in period recommended by manufacturer.
9. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

10. Calibrate thermostats.
11. Adjust and inspect high-temperature limits.
12. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
13. After startup and performance testing, verify bearing lubrication, and adjust belt tension.
14. Verify outdoor-air damper operation.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 15564

SECTION 15566 - PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes indirect-fired makeup-air units.

1.2 DEFINITIONS

A. BAS: Building automation system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and configuration of outdoor, indirect-fired makeup-air unit.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type and configuration of outdoor, indirect-fired heating and ventilating unit.
1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Startup service reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect-fired makeup-air units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each unit.
2. Fan Belts: One set for each unit.
3. Provide fixed pitch pulleys for belt driven fans. Provide replacement pulley sized by balancing contractor to achieve design airflows.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of indirect-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Modine Manufacturing Company.
2. Reznor/Thomas & Betts.
3. Sterling HVAC Products.
4. Titan Air Incorporated.
5. Trane.

2.2 SYSTEM DESCRIPTION

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas burner to be installed exterior to the building.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
3. Casing Coating: Hot-dip galvanized.
4. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Configuration: Horizontal unit with horizontal discharge for curb mounting installation.

C. Cabinet: Galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Duct flanges at inlet and outlet.
1. Double-wall casing with inner wall of solid steel.

2. Internal Insulation: Fibrous-glass duct lining, neoprene coated, comply with ASTM C 1071, Type II, applied on complete unit.
a. Insulation Adhesive: Comply with ASTM C 916, Type I.

2.4 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.5 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

B. Curb Height: 36 inches (910 mm).

2.6 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel.

B. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

C. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

2.7 AIR FILTERS

A. Comply with NFPA 90A.

B. Disposable Panel Filters: Factory-fabricated, pleated-type, disposable air filters with holding frames, with a MERV 7 according to ASHRAE 52.2].

1. Thickness: 2 inches (50 mm).
2. Frame: Galvanized steel.

2.8 DAMPERS

A. Outdoor-Air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. (51 L/s per sq. m) of damper area, at a differential pressure of 2-inch wg (448 Pa).

B. Damper Operator: Direct coupled, electronic with spring return.

2.9 INDIRECT-FIRED GAS BURNER

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and with NFPA 54, "National Fuel Gas Code."

1. CSA Approval: Designed and certified by and bearing label of CSA.
2. Burners: Stainless steel.

a. Gas Control Valve: Two stages per furnace section, four stages minimum for unit.
b. Fuel: Natural gas.
c. Minimum Combustion Efficiency: 80 percent.
d. Ignition: Electronically controlled electric spark with flame sensor.

B. Venting: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.

C. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.

D. Heat Exchanger: Stainless steel.

E. Safety Controls:

1. Vent Flow Verification.
2. Control Transformer: 24-V ac.

3. High Limit: Thermal switch or fuse to stop burner.
4. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
6. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
7. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
8. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.10 CONTROLS

A. Comply with requirements in Section 15900 "HVAC Instrumentation and Controls" and Section 15940 "Sequence of Operation" for control equipment and sequence of operation.

2.11 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 15058 "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Unit Support: Install heating and ventilating unit level on curb.

B. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

C. Install controls and equipment shipped by manufacturer for field installation with indirect-fired heating and ventilating units.

D. Roof Curb: Install on concrete base, level and secure, according to ARI Guideline B. Secure units to upper curb rail, and secure curb base to concrete base with anchor bolts.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service.

B. Duct Connections: Connect supply ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 15820 "Duct Accessories" for flexible duct connectors.

C. Ground equipment according to Section 16060 "Grounding and Bonding."

D. Connect wiring according to Section 16120 "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to burner combustion chamber.
2. Inspect casing insulation for integrity, moisture content, and adhesion.
3. Verify that clearances have been provided for servicing.
4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Verify bearing lubrication.
8. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
9. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
8. Inspect controls for correct sequencing of heating, dampersn, and normal and emergency shutdown.

9. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
10. Verify outdoor-air damper operation.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 15566

SECTION 15710 - HYDRONIC AND STEAM HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes plate heat exchangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which heat exchangers will be attached.

B. Sample Warranty: For manufacturer's warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GASKETED-PLATE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alfa Laval Inc.
2. Armstrong Pumps, Inc.
3. ITT Corporation; Bell & Gossett.
4. TACO Incorporated.
5. Thermo Dynamics Ltd.

B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

D. Frame:

1. Capacity to accommodate 20 percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

E. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger carrying and guide bars are anchored to building structure.

F. End-Plate Material: Painted carbon steel.

G. Tie Rods and Nuts: Steel or stainless steel.

H. Plate Material: 0.024 inch (0.6 mm) thick before stamping; Type 304 stainless steel.

I. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

1. NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
2. NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

J. Enclose plates removable insulated jacket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GASKETED-PLATE HEAT-EXCHANGER INSTALLATION

A. Install insulated jacket over installed gasketed-plate heat exchanger according to manufacturer's written instructions.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Section 15181 "Hydronic Piping" and Section 15179 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for service, and maintenance.

C. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

D. Install shutoff valves at heat-exchanger inlet and outlet connections.

E. Install thermometer on heat-exchanger and inlet and outlet piping. Comply with requirements for thermometers specified in Section 15127 "Meters and Gages for HVAC Piping."

F. Install pressure gages on heat-exchanger inlet and outlet piping. Comply with requirements for pressure gages specified in Section 15127 "Meters and Gages for HVAC Piping."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 15710

SECTION 15732 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Hot-gas reheat.
3. Gas furnace.
4. Outdoor-air damper section.
5. Outdoor air, Discharge temperature and supply dewpoint controls.

B. Related Sections include the following:

1. Section 15564 "Indoor, Indirect, Gas-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air with heat exchangers.

2. Section 15566 "Packaged, Indirect Fired, Outdoor Heating Only Make-Up Air Units" for outdoor units providing 100 percent tempered outdoor air with heat exchangers.

1.2 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, ddc controllers, sensors, control hardware and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.
2. openings
3. curbs and flashing.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: (where applicable) One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

1.7 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
1. Cooling EER per schedule

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard parts and labor warranty and extended warranty for a total of five years, from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin Rebel
2. Pre-approved Equal.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Panel construction shall be double-wall construction for all panels including the floor panels. Equipment shall have an under floor liner. Insulation shall be a minimum of 1" thick with anR-value of 7.0 and shall be 2 part injected foam.Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

C. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs. Exterior surfaces shall be constructed of prepainted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

A. Service doors shall be provided on the fan section,filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

B. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

C. Condensate Drain Pans: Formed sections of stainless-steel sheet, and complying with ASHRAE 62.1.
   1. Drain Connections: Threaded nipple.

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

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A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan.The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft.

B. Fan assembly shall be a slide out assembly for servicing and maintenanace

C. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment

D. The fan motor shall be a totally enclosed EC motor that may be speed controlled by the rooftop unit controller or use for balancing. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

E. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.4 COILS

A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.

B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.

C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.

D. Each coil shall be factory leak tested with high pressure air under water.

2.5 COILS

A. Supply-Air Refrigerant Coil:

1. High efficiency aluminum-plate fin and seamless high efficiency copper tube in steel casing with equalizing-type vertical distributor.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.

C. All coils shall be factory leak tested

2.6 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two

B. Compressor: Hermetic, scroll, variable capacity, inverter compressor, or digital scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief[, and crankcase heater].

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Hot-gas reheat solenoid valve with a replaceable magnetic coil.

2.7 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2. Pleated: Minimum 90 percent arrestance, and MERV 7

B. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" construction filters. The contractor shall furnish and install, at building occupancy, the final set offilters per the contract documents.

2.8 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

E. Safety Controls:

1. Gas Control Valve: 10:1 modulation

2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
3. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.

2.9 MOUNTING

A. A prefabricated heavy-gauge galvanized stee support or mounting curb shall be provided with height as noted in the drawing curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section.

2.10 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air, with motorized damper. The outdoor air hood shall be factory installed and constructed from the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The damper blades shall be gasketed with side seals to provide an air leakage rate of 4 cfm/square foot of damper area at 1" differential pressure per ASHRAE 90.1 Energy Standard.

2.11 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

A. Control equipment and sequence of operation are specified in Section 15900 "HVAC Instrumentation and Controls." Coordinate with control sequence and provide all other necessary sensors and control hardware, to successfully implement the RTU-1/DH-1 control sequence. Any sensors to be located outdoors shall be rated for use in outdoor environment or in a NEMA 4 enclosure.

B. DDC Controller:

1. Controller shall have volatile-memory backup.

2. Supply Fan Operation: Run fan continuously.

3. Refrigerant Circuit Operation: Cycle compressors, modulate compressor speed to match compressor output to cooling load to maintain discharge temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure.

4. Hot-Gas Reheat-Coil Operation: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.

5. Gas Furnace Operation: Modulate burner to maintain discharge temperature.

6. Fixed Minimum Outdoor-Air Damper Operation: Occupied Periods: Open to 100 percent.
   a. Unit shut down: Close the outdoor-air damper.

C. Interface Requirements for HVAC Instrumentation and Control System:
1. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
2. Provide BACnet compatible interface for central HVAC control workstation for the following:

   a. Adjusting set points.
   b. Monitoring supply fan start, stop, and operation.
   c. Inquiring data to include outdoor-air damper position, supply-air temperature and humidity.

2.13 ACCESSORIES

A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

B. Provide all other accessories and options as indicated in the equipment schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install RTUs on 36” high fabricated steel support set on cast-in-place concrete equipment bases.

B. Unit Support: Install unit level. Secure RTUs to structural support with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to spill at grade.

B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
1. Connect supply ducts to RTUs with flexible duct connectors specified in Section 15820 "Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Participate in the RTU-1/DH-1 commissioning.

C. Perform tests and inspections and prepare test reports.

D. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.

6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Verify lubrication on fan and motor bearings.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

16. Inspect and record performance of interlocks and protective devices; verify sequences.
17. Operate unit for an initial period as recommended or required by manufacturer.
18. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

19. Calibrate thermostats.
20. Adjust and inspect high-temperature limits.
21. Inspect outdoor-air dampers for proper stroke.
22. Start refrigeration system and measure and record the following when ambient is a minimum of 75 deg F (24 deg C) above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air-coil, discharge-air, dry-bulb temperature.

23. Inspect controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.

24. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 01820 "Demonstration and Training."

B. Participate in RTU-1/DH-1 commissioning as required by the commissioning plan.

END OF SECTION 15732

SECTION 15814 - BURIED DUCTWORK

PART 1 - GENERAL

1.01 SUMMARY

A. This Section, along with the drawings and the requirements of related specifications, prescribes the basic methods and materials of the lined and coated buried ductwork systems. Provide all labor, materials, equipment, services, transportation, and facilities to furnish, install, test, and adjust the complete Ductwork system as indicated herein and as shown on the drawings.

1.02 RELATED WORK:

A. Examine all other portions of the Subcontract documents for work related to the work of this Section. Provide all work hereunder as required for the support and accommodation of related work.

1.03 TERMINOLOGY:

A. Supply/Exhaust Ductwork and Supply/Exhaust Pipe shall be used interchangeably.

1.04 SUBMITTALS:

A. Submit piping layout drawings showing location and dimensions of all pipe/duct and fittings. Include laying length and other equipment determining piping dimensions. Show fitting details and welding details.

B. Submit material of construction with ASTM reference and grade, wall thickness of steel pipe and fittings.

C. Submit details of epoxy lining and coating, thickness, materials and testing.

1.06 MARKING AND STORAGE:

A. Mark each section of ductwork delivered to the project site with a unique section number indicated on the shop drawings.

B. Store ductwork under roof. Ductwork stored outdoors and exposed to the weather shall be removed from the project site, cleaned or replaced with new.

C. Protect the lining and coating of the pipe from damage or scratches. Cover pipe with plastic sheets and secure until ready for installation.

PART 2 - PRODUCTS

2.01 BURIED DUCTWORK:

A.. Provide buried welded steel pipe/ductwork for supply and exhaust air as indicated on drawings.

a. Pipe for size less than 18” shall be welded black carbon steel conforming to ASTM-A53

b. Pipe for size 24” and larger shall be Spiralweld pipe buttweld and in accordance with ASTM A-139,Grade B.

b. ASTM A53 steel pipe shall be standard schedule. ASTM A139 pipe shall be constructed of 1/4" thick wall carbon sheet steel.

c. Fittings to interface with ventilation unit shall be 1/4" wall miterweld steel with ASME Plate Steel Flanges attached to align with supply and exhaust ventilator units. Provide bolts and gaskets for flanged connections to ventilator units. Fittings to interface with exhaust or supply grille shall be as detailed in the drawings. Fittings to interface with exterior exposed non-metal ductwork shall be 150 lb flange.

2.02 COATINGS

A. Exterior coating shall be Coal Tar Epoxy 16 mils.

B. Coatings shall meet the physical and performance requirements of the American Petroleum Institute, API RP 5L2 and comply with the VOC (Volatile Organic Compound) emission regulations.

C. Surface preparation and application shall be in accordance with the recommendations and practices of the coating manufacturer.

2.03 LINING

A. Provide buried pipe with shop-applied 3M Scotchkote 323 coating, or approved equal with minimum thickness of 25 mils. Lined coating shall be applied by certified 3M installer with proper equipment. Sleeve with heat shielded patting shall be inserted at the ends. The sleeve shall absorb majority of heat from welding connections of pipe and fittings. (Vendor contact for Scotchkote 323 product Steve Hall, smhall2@mmm.com, 507-217-7174)

B. Surface preparation and application shall be in accordance with the recommendations and practices of the coating manufacturer

2.04 BURIED INSULATION:

A. For supply ductwork installed 4 foot below grade, provide 2 inch thick insulation as indicated on the drawings. Insulation shall be flexible unicellular insulation conforming to ASTM C 534, Class S (sheet).Provide protective jacket made of sheet aluminum in accordance with ASTM B 209, 3003 alloy, H-14 temper, 0.016 inch thick. Provide a moisture barrier lining and 3/4 inch wide screwlock stainless steel bands.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Clean and Pretreat Surfaces before application of sealant as follows:

a. Conform to the manufacturer's cleaning procedures.

b. Install sealants in conformance with manufacturer's instructions.

B. Provide Fittings shown on approved shop drawings, and bolt flanged equipment to ductwork with companion flanges.

C. Buried Ductwork/Pipe: Refer to Division 2 specification for procedures in excavation, backfill and compaction for underground piping installation.

3.02 FABRICATION, ASSEMBLY, AND ERECTION

A. Beveled ends for butt welding shall confirm to ASME B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, slag, and other material detrimental to welding. When welding the reverse side, chip out slag before welding.

B. Apply full penetration weld to exterior joint of butt welded pipe , fittings, and welding enck flanges.

3.03 FIELD QUALITY CONTROL:

A. Do Not Insulate or Conceal Ductwork before inspection by Fermilab Contraction Coordinator.

B. Leak Test:

a. Provide test fans, orifices, temporary power and instrumentation in accordance with SMACNA testing specifications. Submit test report for each test.

b. Perform leak tests in accordance with SMACNA standards and record data. If leak test falls within specified limits, then this portion of ductwork shall serve as a standard of quality for the remainder of the project.

c. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements

d. Conduct tests at static pressure equal to maximum design pressure of system or section being tested. If static pressure classes are not indicated, test entire system at maximum design operating pressure.

3.04. CLEANING

A. CLEAN the accessible ductwork before testing, adjusting, balancing and starting any fans.

END OF SECTION 15814

SECTION 15815 - METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:

1. Rectangular ducts and fittings.
2. Single-wall, round, and flat-oval spiral-seam ducts and formed fittings.
3. Double-wall, round, and flat-oval spiral-seam ducts and formed fittings.

1.02 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Welding certificates.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.06 DELIVERY, STORAGE AND HANDLING

A. Materials delivered to the site must be coordinated with the site supervisor prior to delivery.

B. All materials shall be stored in a designated area and protected from the environment.

C. All materials shall be secured so as not to be a hazard during the construction process.

D. All materials must be free of all dirt, debris and moisture during the installation process.

1.07 WARRANTY

A. Minimum one year warranty on all material and labor from substantial completion date.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Ductmate Industries, Inc.
2. Lindab

3. Lockformer
4. McGill Airflow
5. Nexus Inc.
6. Semco, Inc.
7. Ward Industries

2.02 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

E. Insulated Flexible Ducts: Flexible ducts wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.

2.03 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

C. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

D. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

E. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.04 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.05 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.06 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Flat-Oval, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible. Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
   a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
   b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
   c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
   d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
   a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
   b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
   c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
   d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
9. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
10. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

2.07 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.

2. Insulation: 2 inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
   a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
   a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
   b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
   c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
   d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.
4. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

B. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:

   a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.

   b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.

   c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.

2.08 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts: +2.
2. Return Ducts (Negative Pressure): -2”.
3. Exhaust Ducts (Negative Pressure): -2”.

B. See schedule on drawings for regarding duct types required for each system.

2.09 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."

O. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction.

2.13 SEAM AND JOINT SEALING

A. Seal all duct seams and joints in accordance with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

B. Seal ducts before external insulation is applied.

2.14 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

2.15 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

PART 3 - EXECUTION

3.01 CLEANING NEW SYSTEMS

A. Clean duct system(s) before testing, adjusting, and balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

E. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and reinspect ducts.

END OF SECTION 15815

SECTION 15816 - NONMETAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermoset FRP ducts and fittings.

B. Related Sections:

   1. Section 15815 "Metal Ducts" for single- and double-wall, rectangular and round ducts.
   2. Section 15820 "Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.
   3. Section 15950 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for nonmetal ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Fibrous Glass Duct Construction Standards" and performance requirements and design criteria indicated.

   1. Static-Pressure Classes:

      a. Supply Ducts: 3-inch wg (500 Pa).
      b. Exhaust Ducts (Negative Pressure): 2-inch wg (500 Pa).

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Thermoset FRP duct materials.

B. Shop Drawings:

   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.
   3. Elevation of top of ducts.
   4. Dimensions of main duct runs from building grid lines.
   5. Fittings.
   6. Reinforcement and spacing.
   7. Seam and joint construction.

8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:

1. Duct materials and thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

C. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 THERMOSET FRP DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. McGill AirFlow LLC.
2. Perry Fiberglass Products, Inc.
3. Spunstrand Inc.

B. Duct and Fittings:
1. Inner Liner: FSK liner rated by an NRTL to comply with UL 181, Class 1.

2. Round Duct: ASTM D 2996, Type I, Grade 2, Class E, filament-wound duct, minimum 0.125-inch (3.2-mm) wall thickness for sizes 20” and smaller and 0.187-inch (4.7-mm) wall thickness for sizes greater than 20” and, with tapered bell and spigot ends for adhesive joints, or plain ends with couplings.
3. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and joining method as duct.
4. Rectangular Fittings: Minimum 0.125-inch- (3.2-mm-) thick flat sheet with fiberglass roving and resin-reinforced joints and seams.
5. Double-Wall Insulated Duct: Inner and outer duct complying with requirements for "Round Duct" description above. Polyurethane foam or isocyanurate insulation with maximum thermal conductivity of 0.07 Btu x in./h x sq. ft. x deg F at 75 deg F (24 deg C) mean temperature.
   a. Where double-wall insulated duct transitions to single-wall duct, completely encapsulate insulation at end.
6. Increase duct thickness beyond minimums identified above as required by project conditions including pressure classification, burial depth, etc.
7. Provide factory applied UV protective coating on exterior of all ductwork being installed exposed above grade.

C. Joining Materials: Roving and polyester resin.

1. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.

2.2 HANGERS AND SUPPORTS

A. Hanger Rods: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Install ducts with fewest possible joints.

B. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

C. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

D. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

E. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

F. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."

G. Install all underground ductwork pitched to drain to the supply outlet or return or exhaust air inlet as applicable so as to eliminate the possibility of water being trapped within the ductwork.

H. Pressure test all underground ductwork to zero leakage prior to backfilling. Repair all leaks found during pressure testing.

3.2 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

C. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test 100% of all FRP duct systems.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Section 15820 "Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Mechanical Cleaning Methodology:

1. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

2. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.
3. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
4. Provide drainage and cleanup for wash-down procedures.
5. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.5 START UP

A. Air Balance: Comply with requirements in Section 15950 "Testing, Adjusting, and Balancing."

3.6 DUCT SCHEDULE

A. Outdoor Ducts and Fittings:

1. Thermoset FRP Round Ducts and Fittings:
   a. Supply ducts: Single-Wall and Double-Wall Insulated Ducts: Minimum 2-inch (50-mm) insulation thickness. See Duct & Plenum Insulation Schedule on the drawings.
   b. Exhaust ducts: Single-Wall.
   c. Provide factory applied UV protective coating on exterior of all ductwork being installed exposed above grade.

B. Underground Ducts:

1. Thermoset FRP Round Ducts and Fittings:

   a. Single-Wall and Double-Wall Insulated Ducts: Minimum 2-inch (50-mm) insulation thickness. See Duct & Plenum Insulation Schedule on the drawings.

END OF SECTION 15816

SECTION 15820 - DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Fire dampers.
4. Turning vanes.
5. Duct-mounting access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Duct accessory hardware.

1.02 DEFINITIONS – NOT APPLICABLE

1.03 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Fire dampers.
4. Turning vanes.
5. Duct-mounting access doors.
6. Flexible connectors.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Special fittings.
2. Manual-volume damper installations.
3. Motorized-control damper installations.
4. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
5. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.06 DELIVERY, STORAGE AND HANDLING

A. Materials delivered to the site must be coordinated with the site supervisor prior to delivery.

B. All materials shall be stored in a designated area and protected from the environment.

C. All materials shall be secured so as not to be a hazard during the construction process.

D. All materials must be free of all dirt, debris and moisture during the installation process.

1.07 WARRANTY

A. Minimum one year warranty on all material and labor from substantial completion date.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. BACKDRAFT DAMPERS:
   a. Greenheck
   b. Ruskin
   c. Vent Products Company
2. VOLUME DAMPERS
   a. Nailor
   b. Ruskin
   c. Vent Products Company
3. FIRE DAMPERS
   a. Greenheck
   b. Ruskin
   c. Vent Products Company
4. DUCT-MOUNTING ACCESS DOORS
   a. CESCO Products
   b. Ductmate Industries
   c. Greenheck
5. FLEXIBLE CONNECTORS
   a. Ductmate Industries
   b. Ventfabrics, Inc.

c. Ward Industries

2.02 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M Type 304 (specify Type 314 as required by the application).

D. Aluminum Sheets: ASTM B 209 alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 BACKDRAFT DAMPERS

A. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

B. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.

C. Blades: 0.050-inch thick aluminum sheet.

D. Blade Seals: Neoprene.

E. Blade Axles: Galvanized steel.

F. Tie Bars and Brackets: Galvanized steel.

G. Return Spring: Adjustable tension.

2.04 VOLUME DAMPERS

A. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct

penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve.
8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.

C. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications. Automatic dampers shall be fitted with DDC actuators (Belimo or equal) with sufficient torque to open and close dampers smoothly. Multiple dampers-actuators shall be required for louver / damper of large dimensions.
1. Steel Frames: galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve thrust or ball.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Aluminum.

D. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.05 FIRE DAMPERS

A. Fire dampers shall be labeled according to UL 555.

B. Fire Rating: Insert rating as required by application hours.

C. Frame: Curtain type with blades outside airstream fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

D. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

E. Mounting Orientation: Vertical or horizontal as indicated.

F. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

G. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

H. Fusible Links: Replaceable, 165 deg F rated.

2.07 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.08 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
2. Provide number of hinges and locks as follows:
   a. Less Than 12 Inches Square: Secure with two sash locks.
   b. Up to 18 Inches Square: Two hinges and two sash locks.
   c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Frame: Galvanized sheet steel, with spin-in notched frame.

2.09 FLEXIBLE CONNECTORS

A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated and at the discharge of supply fans where systems are headered together.

D. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

E. Provide test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

G. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Downstream from volume dampers,turning vanes, and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.
6. Where indicated on plans.

H. Label access doors according to Division 15 Section "Mechanical Identification."

I. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

J. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

K. Install duct test holes where indicated and required for testing and balancing purposes.

3.02 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

3.05 DEMONSTRATION AND COMMISSIONING

D. Demonstrate proper operation of equipment to commissioning agent or designated owners personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements.

1. For all fire dampers or access doors for fire dampers installed on this project the Contractor will demonstrate that any fire dampers selected by the owner can be dropped and reset using the provided access doors.

END OF SECTION 15820

SECTION 15838 - POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Centrifugal roof ventilators.
   2. Axial roof ventilators.
   3. In-line centrifugal fans.
   4. Propeller fans.

1.2 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

2. Provide fixed pitch pulleys for belt driven fans. Provide replacement pulley sized by balancing contractor to achieve design airflows.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent for use in air balancing purposes.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 24 inches (610 mm).
3. Pitch Mounting: Manufacture curb for roof slope.

2.2 AXIAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Wind Band, Fan Housing, and Base: Reinforced and braced welded steel with powder coated finish, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

C. Hinged access door permitting service and maintenance.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

2.3 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Housing: Steel, lined with acoustical insulation.

C. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

D. Fan Wheels: Aluminum, backward inclined blades welded to aluminum hub.

E. Accessories:
1. Companion Flanges: For inlet and outlet duct connections.
2. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

3. Vibration Isolators:

a. Type: Combination spring / neoprene isolator based on Mason Model 30N.
b. Static Deflection: 1 inch (25 mm).

2.4 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Drive:

1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Service Factor Based on Fan Motor Size: 1.4.
5. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

6. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
7. Motor Pulleys: Fixed pitch.
8. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
9. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

E. Accessories:
1. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. Wall Sleeve: Galvanized steel to match fan and accessory size.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15058 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.6 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Install power ventilators on cast-in-place concrete equipment base(s) where indicated.

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

D. Support suspended units from structure using threaded steel rods and elastomeric / spring hangers.

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Section 15077 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 15820 "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 16060 "Grounding and Bonding."

D. Connect wiring according to Section 16120 "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 15950 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 15838

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes ceiling, wall and duct-mounted diffusers, registers, and grilles.

1.02 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.03 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

1.04 QUALITY ASSURANCE

A. ARI Compliance: Test and rate diffusers, registers, and grilles in accordance with ARI 650 "Standard for Diffusers, registers, and grilles".

B. ASHRAE Compliance: Test and rate diffusers, registers, and grilles in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

C. ADC Compliance: Test and rate diffusers, registers, and grilles in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

D. ADC Seal: Provide diffusers, registers, and grilles bearing ADC Certified Rating Seal.

E. NFPA Compliance: Install diffusers, registers, and grilles in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver diffusers, registers, and grilles wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store diffusers, registers, and grilles in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

1.06 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide diffusers by one of the following:

1. Ceiling or duct-mounted air diffusers and/or Duct-Mounted Diffusers:
   a. Nailor
   b. Titus Products Div.; Philips Industries, Inc.
   c. Tuttle & Bailey; Div. of Interpace Corp.
   d. Price Industries
2. Wall Registers and Grilles
   a. Nailor
   b. Titus Products Div.; Philips Industries, Inc.
   c. Tuttle & Bailey; Div. of Interpace Corp.
   d. Price Industries

2.02 CEILING AIR DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling or duct-mounted air diffusers where shown; of size, shape, capacity

and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling or duct-mounted air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling or duct-mounted diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.

2.03 REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall, ceiling, or ductwork systems, and that are specifically manufactured to fit into construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.

D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on schedule.

2.04 DOOR AND TRANSFER GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Construction: Outer borders shall be constructed of heavy extruded aluminum and shall have countersunk screw holes for a neat appearance. Border shall be interlocked at the four corners and mechanically staked to form a rigid frame. Extruded aluminum inverted V-blades with a deflection

shall be used to create a sight proof design and provide additional stiffness to the grille.

D. Types: Provide wall grilles of type, capacity, and with accessories and finishes as listed on schedule.

2.05 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.04 CONTRACTOR STARTUP AND REPORTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 15855

SECTION 15940 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control sequences for HVAC Air Handling and Chilled Water systems, subsystems, and equipment.

B. Refer to CHW/CG Piping Diagram on drawing M-11; control diagrams on drawings M-18, 19 and 20; and the Input / Output Schedule on drawing M-22 for additional information associated with the following Sequences of Operation.

C. Related Sections include the following:

1. Division 15 Section 15010 “General Provisions for Mechanical Work” for HVAC design criteria, systems description, etc.
2. Division 15 Section 15900 “HVAC Instrumentation and Controls” for control equipment and devices and for submittal requirements.

D. The chilled water systems in Building Mu2e consist of a piping connection between the Campus distribution system and the building HVAC systems:

1. HVAC chilled water pumps with variable frequency drives,
2. HVAC plate-and-frame heat exchanger,
3. Water flow meters,
4. Temperature sensors,
5. Pressure sensors,
6. Chemical feed tanks and filters,
7. Isolation valves,
8. Flow control valves,
9. Check valves.

E. The air handling systems in Building Mu2e consist of:

1. Centrifugal supply fans
2. In-line return fans
3. Variable frequency drives
4. Dampers
5. Filters
6. Chilled water coils
7. Gas fired furnaces
8. Packaged outdoor air conditioning unit
9. Desiccant dehumidification unit

F. Miscellaneous:

1. Gas meter
2. Water meter
3. Electric meter
4. Sump pumps

1.2 SUBMITTALS

A. Contractor shall provide a written sequence of operation, specifically addressing any exceptions to this specification. Submit with shop drawings for Section 15975.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide all sensors, DDC operators and programming required for systems to perform as described in this section.

PART 3 EXECUTION

3.01 CHILLED WATER CONTROL SEQUENCES

A. General

1. Building Mu2e is served with chilled water from the campus chilled water system. A heat exchanger is provided to isolate the campus system from the building side distribution system. In general, the campus (cold) side of the heat exchanger is operated at a design chilled water supply (CHWS) temperature of 44°F, and a design chilled water return (CHWR) temperature of 54°F.
2. There is one plate-and-frame heat exchanger connected to the campus chilled water system. The HX is designed to operate with a 10°F temperature differential between the supply and return. The chilled water on the building (hot) side of both heat exchangers is designed for 46°F CHWS and 56°F CHWR and is to include a glycol solution.
3. The purpose of the HVAC chilled water distribution system is to distribute chilled water to four (4) air handling units and an owner provided RAW skid. One (1) computer room air handling unit, an owner provided Tracker cooling system and taps for owner provided DS dehumidifier shall be connected on the Campus side of the chilled water system, upstream of the heat exchanger.
4. The chilled water systems in this building are designed to operate throughout the year (24/7), whenever necessary.
5. All setpoints and time limits etc. will be adjustable in the field or through software logic

B. Flow Meter

1. Measurement of instantaneous building tonnage will be calculated by the BAS using the following inputs:
2. Chilled water supply flow from the new campus chilled water flow meter.
3. New campus chilled water supply temperature sensor.
4. New campus chilled water return temperature sensor

C. Pressure

1. In the HVAC chilled water distribution, differential pressure, DPT, will be sensed and used to control the speed of the heat exchanger chilled water pump. The differential pressure is the DP between the chilled water supply and return at a remote location in the chilled water distribution system

D. Pump Starting/Stopping

1. When the system is enabled, the lead chilled water pump shall be scheduled to run continuously.
   a. The HVAC chilled water pump will start at minimum speed and shall operate at minimum speed for the first 2 minutes (adj). After that time, it shall gradually ramp up, as required to operate under normal remote static pressure setpoint control.
2. The building chilled water system has two pumps, P-01 and P-02 to distribute HVAC chilled water to the air handlers. Each of the pumps is sized at 100% of its design flow rate. Only one pump is required to provide the required chilled water flow to satisfy the cooling requirement of that loop. Alternate the lead / lag status of each pump weekly (adj). Upon failure of the lead pump, the lag pump shall be automatically started and an alarm shall be initiated at the BAS. Once status of lead pump returns for 1 minute (adj) lag pump shall shut down.
3. The HVAC chilled water pumps will operate in accordance with a Normal/Standby sequence with an exercise cycle. The specific details of this sequence are given, below.

E. HVAC Pump Speed Control - Optimized Differential Pressure Reset (Trim and Respond)

1. General: The objective is to minimize pump energy by always operating at the lowest speed possible. The minimum pump speed shall be programmed at the VFD drive for 33% or 20 hertz (ADJ) or in the software. The maximum pump speed shall be programmed at the VFD drive for 100% or 60 hertz.
2. Basic VFD speed control: The remote DPT setpoint shall modulate the pump VFD speed to maintain a differential pressure setpoint. The differential pressure setpoint shall be automatically adjusted based on the positions of the chilled water control valves in the system. Adjust the differential setpoint so that at least one cooling control valve is fully open while maintaining the associated AHU's temperature control setpoint within an acceptable range.
3. HVAC pump deadhead protection: Provide a pressure bypass valve near the end of the system piping. As the chilled water pump speed is decreased below 40% speed (adj) the bypass valve shall start to modulate open. Modulate the bypass valve to maintain the pump speed between 33% – 40%. As the pump speed increases above 40% the valve shall be fully closed.

F. Campus Chilled Water Valves Flow and Temperature Control

1. When the HVAC pumps are not enabled, the flow control valve shall be in its normally-closed, minimum position.
2. The temperature control valve shall modulate from minimum position (ADJ) to 100% open to maintain HVAC chilled water supply temperature setpoint of 46°F (ADJ).

G. HVAC Pump Exercise and System Chemical Treatment

1. This sequence is to allow chemical treatment introduced at the pot feeder to distribute the chemicals to all the HVAC piping system components and to filter the HVAC chilled water on a timely basis.
2. If the HVAC chilled water system was enabled or if the chilled water vavles are open, for less than one (1) hour during a consecutive seven (7) day period then:
   a. If the pump is not already running at its minimum speed, the HVAC pumps shall be run for 30 minutes (ADJ, minimum of 15 minutes). Pump control shall follow the HVAC Pump Sequences indicated above.
   b. The chilled water valves at each of the four (4) AHUs shall be opened in individually to 50% for 1/4 the exercise time period. Then it will close and the next AHU valve shall be open 50% for the 1/4 of the exercise time period.

H. Miscellaneous Alarms

1. Pump Control Fault
   a. Unstable: Any pump speed continues to cycle its output more than 40% of its range (ADJ) 3 times (ADJ) in any 60 minute internal.
   b. Excessive Pump Speed: Pump speed output remains above 95% for more than 8 hours (ADJ) accumulated per occupied period for at least 3 (ADJ) consecutive occupied periods.
   c. Continuous Request Alarm: If one or more application controllers is sending continuous cooling requests, and differential pressure has reset to maximum setpoint, and the combined condition remains for more than 8 hours (ADJ).

3.02 AHU-1 / DF-1 –SOLENOID & POWER SUPPLY ROOM – SEQUENCE OF OPERATION

A. Air Handler Start

1. AHU-1 is a single zone, variable air volume air handling unit with a roof mounted relief opening.
   a. Supply air volume varies in response to load.
   b. Heating and cooling fluctuate to maintain the discharge air temperature (DAT)
2. Modes of operation shall be selectable and scheduled through the BAS.

a. Experimental Mode: System will run all the time, priority is pressurization-then space condition.
b. Installation Mode (Occupied): System will run based on schedule. Pressurization is not a priority. Fan will run continously. Unit to maintain occupied setpoints.
c. Installation Mode (Unoccupied): System will run based on schedule. Pressurization is not a priority. Fan shall cycle off when setpoints are met. Unit to maintain unnoccupied setpoints

3. When the air handling unit is off:
   a. The outdoor air and relief air dampers are in their normal, fully closed position.
   b. The return air damper is fully open.
   c. The chilled water valve is fully closed.
   d. The gas furnace is off.
   e. Supply fans is off.
4. Air Handling Unit started under control of the Metasys BAS:
   a. An adaptive optimal start algorithm shall be used to minimize the energy required and warm-up or cool-down time during the unoccupied period, while achieving zone occupied temperature setpoints by the start of scheduled occupied period. The learning adaptive algorithm shall compare the zone temperature to its setpoint at beginning of scheduled occupied period and shall automatically adapt the heating or cooling response time for the next unoccupied period.
   b. On verification that all safeties are satisfied, the supply air fan will start. The supply fan will run continuously during occupied periods. The BAS modulates the variable speed fan drive to maintain space temperature
      1) Alarm if fan fails to start.
      2) Set variable speed drive to minimum speed as fan is stopped.
   c. Freeze Protection: An AHU mounted temperature sensor, located before the supply fan shall signal an alarm at the BAS when the mixed air temperature drops below 38°F (ADJ). Because of the critical nature of the experiment, the unit shall continue to run. Upon sensing of discharge air temperature (DAT) below 38°F (ADJ) the system shall stop and initiate an alarm at the BAS.
   d. Smoke Control: Smoke detectors furnished by Division 16, located in the supply & return air duct signals an alarm, and stops the fans when products of combustion are detected in the airstream. Smoke sequence shall be through hard wired contacts.

B. Temperature Control

Space temperature is controlled by sequencing discharge air temperature (DAT) and fan speed control. The initial space heating setpoint will be 68°F (ADJ), and the initial space cooling setpoint temperature will be 85°F (ADJ). Space temperature will be sensed by room sensor.

Supply fan shall modulate through the minimum and maximum speed (airflow) range setpoint to maintain the space temperature (described below). Speed adjustment shall be slow action to avoid hunting of variable frequency drives.

1. Heating Mode:
   When the space temperature approaches the space heating temperature setpoint, the air handling unit control shall be indexed to the heating mode.
   a. First Stage – Modulate DAT from minimum 75°F to maximum 95°F while supply airflow remains at the minimum allowable airflow through the furnace, or minimum ventilation speed setpoint, whichever is greater. Minimum ventilation speed (30% ADJ) shall be defined as the lowest fan speed recommended by the air handling unit and return fan manufacturer.
   b. Second Stage – If space temperature remains below the setpoint, gradually increase airflow from minimum to maximum heating VFD speed
   c. As space temperature rises above the heating setpoint, the reverse shall occur.
2. Deadband: When the space temperature is within the 70°F (ADJ) to 80°F (ADJ) deadband, unit controls shall revert to ventilation, only. The system retains the DAT setpoint from the last control mode, and modulates down to the minimum speed necessary to provide design ventilation CFM.
3. Cooling Mode:
   When the space temperature rises to within 5°F of the space cooling setpoint, the air handling unit controls shall index to the cooling mode and the gas-fired furnace shall be disabled.
   a. First Stage – Reset DAT to 55°F (ADJ) with the supply fan still at minimum ventilation speed.
   b. Second Stage – On a continued rise in space temperature, the fan speed will increase from minimum ventilation speed to maximum design airflow for the air handling unit. The DAT setpoint remains constant at 55°F (ADJ)
   c. As space temperature drops below the cooling setpoint, the reverse shall occur.
4. Unoccupied Mode (Optional during installation mode only. To be completely disabled during experimental mode.): The air handling unit shall cycle between “OFF” and either the heating or cooling mode. The supply fan will cycle, as required, to maintain the unoccupied mode space temperature setpoints. The heating and cooling mode shall operate as described above with the following differences.
   a. The initial unoccupied mode space heating setpoint will be 60°F (ADJ), and the initial space cooling setpoint temperature will be 90°F (ADJ).
   b. Economizer – Minimum position for the economizer shall be set to 0% outside air during unoccupied mode.
   c. At such time that the controls ramp the fan down to low speed for an extended period (15 minutes, ADJ), the fan shall cycle

off. Minimum on / off cycle for the fan shall be 15 minutes (ADJ) to prevent short cycling.

C. Economizer (Mixed Air) Temperature Control:

1. Provide outdoor, relief and return air motorized dampers for use in building ventilation and economizer. Subdivide the outdoor air damper into a minimum OA damper with integral airflow measuring (based on Ruskin Model IAQ50X) and with the remaining portion for use during economizer mode without the requirement for airflow measuring. Select the minimum OA damper size to achieve a face velocity of approximately 1000 fpm (or closest available size) based on the Minimum OA value scheduled for the air handling unit.
2. General – The Metasys BAS shall modulate the outdoor and return dampers in sequence to maintain the mixed air temperature (MAT) setpoint 2°F lower than the discharge temperature (DAT) setpoint. The minimum OA damper shall be modulated based on airflow measurement through the damper to maintain the minimum OA set-point.
3. Economizer control shall be enabled whenever:
   a. Outdoor air temperature is less than 68°F (ADJ).
   b. AND the outdoor air temperature is less than the return air temperature
   c. AND the supply fan status is “ON”
4. Outside air dampers may modulate below minimum damper position to prevent mixed air temperature from dropping below 45°F (ADJ). Initiate a non-critical alarm when this occurs.
5. The outdoor air damper and relief air dampers shall close and the return air damper shall open when:
   a. The freeze protection is activated
   b. OR loss of supply fan on status.
   c. OR if unit is commanded off.
6. Modulate the relief damper to space pressurization. Provide a pressure sensor to measure between the Solenoid & Power Supply Room and the lower level space below (control to 0.02” WC (ADJ) > than lower level). Locate the DP sensor associated with the lower level at a readily accessible location within the Solenoid & Power Supply Room. Modulate the relief damper to maintain the differential pressure between the two spaces.
   a. If the relief damper is commanded closed by the pressure control AND the economizer is operating at minimum OA AND the building pressure is still below the setpoint, modulate the minimum OA damper open up to a maximum of 20% design supply air flow.

D. Cooling Coil Control

1. The Metasys BAS shall monitor the unit Discharge Air temperature (DAT) sensor and use as required for cooling coil control.

2. The chilled water (CHW) control valve shall modulate last in sequence to maintain the unit DAT setpoint. cooling coil control shall be enabled whenever:
   a. DAT exceeds the setpoint.
   b. AND outdoor air temperature is greater than 50°F (ADJ).
   c. AND economizer control is unable to maintain DAT setpoint.
   d. AND the supply fan status is on as indicated by power to the VFD.
3. The BAS shall monitor the cooling coil leaving air temperature and use as required for diagnostics as described in Miscellaneous Alarms.

E. Gas-Fired Heating Furnace Control

1. The Metasys BAS shall measure the discharge air temperature (DAT) and provide output to the furnace control panel.
2. The gas fired furnace shall modulate under its own controls to maintain the heating DAT setpoint.
3. The gas fired furnace shall be enabled whenever:
   a. The space temperature drops to the heating setpoint
   b. AND the supply fan status is on as indicated by power to the VFD and pressure drop across the filter bank.
   c. AND the cooling coil is not active.
   d. AND the OA temperature is below 70°F (ADJ).
4. The furnace shall run whenever:
   a. Discharge air temperature drops below 45°F (ADJ.)

F. Miscellaneous Alarms

1. Filter Differential Pressure Monitor exceeds a user defined limit (adj.).
2. Fan Control Fault – If supply fan speed cycles its output more than 40% of its range (adj.) 3 times (adj.) in any 60 minute internal.
3. The supply fan speed output remains above 95% for more than 8 hours (adj.)
4. Airflow out of range: initial baseline operation shall be determined during commissioning using fan speed and static pressures.
5. VFD left in local Manual Override for more than 12 hours.
6. Damper Control cycles its output more than 40% of its range (adj.) 3 times (adj.) in any 60 minute internal.
7. Chilled water control cycles its output more than 40% of its range (adj.) 3 times (adj.) in any 60 minute internal.
8. Gas-fired furnace output remains above 95% for more than accumulated 8 hours (adj.) per occupied period for at least 3 (adj.) consecutive occupied periods
9. Cooling valve output remains above 95% for more than accumulated 8 hours (adj.) per occupied period for at least 3 (adj.) consecutive occupied periods.
10. Variable Frequency Drives shall be connected to the BAS to monitor, display, trend and report the following points:
    a. Speed output
    b. Hand/Auto selection indication

c. Operating hours
d. Faults

3.03 AHU-2 / DF-2 – DETECTOR SOLENOID AREA – SEQUENCE OF OPERATION

A. Air Handler Start

1. AHU-2 is a single zone, variable air volume air handling unit with a return fan.
   a. Supply air volume varies in response to load.
   b. Heating and cooling fluctuate to maintain the discharge air temperature (DAT)
2. Modes of operation shall be selectable and scheduled through the BAS.
   a. Experimental Mode: System will run all the time. Fan will run continously. Unit to maintain occupied setpoints.
   b. Installation Mode (Occupied): System will run based on schedule. Fan will run continously. Unit to maintain occupied setpoints.
   c. Installation Mode (Unoccupied): System will run based on schedule. Fan shall cycle off when setpoints are met. Unit to maintain unnoccupied setpoints
3. When the air handling unit is off:
   a. The outdoor air and exhaust air dampers are in their normal, fully closed position.
   b. The return air damper is fully open.
   c. The chilled water valve is fully closed.
   d. The gas furnace is off.
   e. Supply and return fans are off.
4. Air Handling Unit started under control of the Metasys BAS:
   a. An adaptive optimal start algorithm shall be used to minimize the energy required and warm-up or cool-down time during the unoccupied period, while achieving zone occupied temperature setpoints by the start of scheduled occupied period. The learning adaptive algorithm shall compare the zone temperature to its setpoint at beginning of scheduled occupied period and shall automatically adapt the heating or cooling response time for the next unoccupied period.
   b. On verification that all safeties are satisfied, the supply air fan will start. The supply fan will run continuously during occupied periods. The BAS modulates the variable speed fan drive to maintain space temperature
      1) Alarm if fan fails to start.
      2) Set variable speed drive to minimum speed as fan is stopped.
   c. The BAS modulates the return air variable speed drive fan to match the supply airflow.
   d. Freeze Protection: An AHU mounted temperature sensor, located before the supply fan shall signal an alarm at the BAS when the mixed air temperature drops below 38°F (ADJ). Because of the critical nature of the experiment, the unit shall

continue to run. Upon sensing of discharge air temperature (DAT) below 38°F (ADJ) the system shall stop and initiate an alarm at the BAS.

e. Smoke Control: Smoke detectors furnished by Division 16, located in the supply and return air duct signals an alarm, and stops the fans when products of combustion are detected in the airstream. Smoke sequence shall be through hard wired contacts.

5. Airflow Tracking Control:
Total system return air shall continuously track supply air cfm according to the following relationship.
   a. RACFM=SACFM-(PACFM)
   b. Supply Airflow (SACFM) and Return Airflow (RACFM) is determined by the each fan's speed and is monitored continuously (Initially set by the balancing contractor and directly proportional to VFD speed).
   c. Pressurization Air / Exfiltration (PACFM): 0 default (ADJ) to achieve a neutral space pressurization.

B. Temperature Control

Space temperature is controlled by sequencing discharge air temperature (DAT) and fan speed control. The initial space heating setpoint will be 68°F (ADJ), and the initial space cooling setpoint temperature will be 80°F (ADJ) Space temperature will be sensed by the average of the return air temperature sensors with the sensor at a readily accessible location within Mechanical Room 111.

Supply fan shall modulate through the minimum and maximum speed (airflow) range setpoint to maintain the space temperature (described below). The return fan will track the supply fan speed. Speed adjustment shall be slow action to avoid hunting of variable frequency drives.

1. Heating Mode:
When the return air temperature approaches the space heating temperature setpoint, the air handling unit control shall be indexed to the heating mode.
   d. First Stage – Modulate DAT from minimum 75°F to maximum 95°F while supply airflow remains at the minimum allowable airflow through the furnace, or minimum ventilation speed setpoint, whichever is greater. Minimum ventilation speed (30% ADJ) shall be defined as the lowest fan speed recommended by the air handling unit and return fan manufacturer.
   e. Second Stage – If space temperature remains below the setpoint, gradually increase airflow from minimum to maximum heating VFD speed
   f. As space temperature rises above the heating setpoint, the reverse shall occur.
2. Deadband: When the space temperature is within the 70°F (ADJ) to 75°F (ADJ) deadband, unit controls shall revert to ventilation, only. The system retains the DAT setpoint from the last control mode, and

modulates down to the minimum speed necessary to provide design ventilation CFM.

3. Cooling Mode:
When the return air temperature rises to within 5°F of the space cooling setpoint, the air handling unit controls shall index to the cooling mode and the gas-fired furnace shall be disabled.
   d. First Stage – Reset DAT to 55°F (ADJ) with the supply fan still at minimum ventilation speed.
   e. Second Stage – On a continued rise in space temperature, the fan speed will increase from minimum ventilation speed to maximum design airflow for the air handling unit. The DAT setpoint remains constant at 55°F (ADJ)
   f. As space temperature drops below the cooling setpoint, the reverse shall occur.

4. Unoccupied Mode (Optional during installation mode only. To be completely disabled during experimental mode.): The air handling unit shall cycle between "OFF" and either the heating or cooling mode. Wider temperature offset ranges will be allowed. The supply fan will cycle, as required, to keep the space within an acceptable temperature range.
   d. Initially, a +/- 3°F (ADJ) drift from the heating and cooling setpoints will be employed. The deadband shall also be increased to a range of 68°F to 78°F. The heating and cooling mode shall operate as described above but with the revised setpoints and deadband.
   e. Economizer – Minimum position for the economizer shall be set to 0% outside air during unoccupied mode.
   f. During unoccupied mode the fans shall be cycled on and off in 15 minute (ADJ) intervals when the space temperature is within the range of the deadband. (The fan cycling shall occur to ensure that the return air temperature sensor is monitoring the temperature in the space.)

C. Economizer (Mixed Air) Temperature Control:

1. Provide outdoor, exhaust and return air motorized dampers for use in building ventilation and economizer. Subdivide the outdoor air damper into a minimum OA damper with integral airflow measuring (based on Ruskin Model IAQ50X) and with the remaining portion for use during economizer mode without the requirement for airflow measuring. Select the minimum OA damper size to achieve a face velocity of approximately 1000 fpm (or closest available size) based on the Minimum OA value scheduled for the air handling.
2. General – The Metasys BAS shall modulate the outdoor, exhaust and return dampers in sequence to maintain the mixed air temperature (MAT) setpoint 2°F lower than the discharge temperature (DAT) setpoint. The minimum OA damper shall be modulated based on airflow measurement through the damper to maintain the minimum OA setpoint.
3. Economizer control shall be enabled whenever:
   d. Outdoor air temperature is less than 68°F (ADJ).

e. AND the outdoor air temperature is less than the return air temperature
f. AND the supply fan status is “ON”

4. Outside air dampers may modulate below minimum damper position to prevent mixed air temperature from dropping below 45°F (ADJ). Initiate a non-critical alarm when this occurs.
5. The outdoor air damper and exhaust air dampers shall close and the return air damper shall open when:
   b. The freeze protection is activated
   c. OR loss of supply fan on status.
   d. OR if unit is commanded off.

D. Cooling Coil Control

1. The Metasys BAS shall monitor the unit Discharge Air temperature (DAT) sensor and use as required for cooling coil control.
2. The chilled water (CHW) control valve shall modulate last in sequence to maintain the unit DAT setpoint. cooling coil control shall be enabled whenever:
   e. DAT exceeds the setpoint.
   f. AND outdoor air temperature is greater than 50°F (ADJ).
   g. AND economizer control is unable to maintain DAT setpoint.
   h. AND the supply fan status is on as indicated by power to the VFD.
3. The BAS shall monitor the cooling coil leaving air temperature and use as required for diagnostics as described in Miscellaneous Alarms.

E. Gas-Fired Heating Furnace Control

1. The Metasys BAS shall measure the discharge air temperature (DAT) and provide output to the furnace control panel.
2. The gas fired furnace shall modulate under its own controls to maintain the heating DAT setpoint.
3. The gas fired furnace shall be enabled whenever:
   e. The space temperature drops to the heating setpoint
   f. AND the supply fan status is on as indicated by power to the VFD and pressure drop across the filter bank.
   g. AND the cooling coil is not active.
   h. AND the OA temperature is below 70°F (ADJ).
4. The furnace shall run whenever:
   b. Discharge air temperature drops below 45°F (ADJ.)

F. Miscellaneous Alarms

1. Filter Differential Pressure Monitor exceeds a user defined limit (adj.).
2. Fan Control Fault – If supply or return fan speed cycles its output more than 40% of its range (adj.) 3 times (adj.) in any 60 minute internal.
3. The supply or return fan speed output remains above 95% for more than 8 hours (adj.)

4. Airflow out of range: initial baseline operation shall be determined during commissioning using fan speed and static pressures.
5. VFD left in local Manual Override for more than 12 hours.
6. Damper Control cycles its output more than 40% of its range (adj.) 3 times (adj.) in any 60 minute internal.
7. Chilled water control cycles its output more than 40% of its range (adj.) 3 times (adj.) in any 60 minute internal.
8. Gas-fired furnace output remains above 95% for more than accumulated 8 hours (adj.) per occupied period for at least 3 (adj.) consecutive occupied periods
9. Cooling valve output remains above 95% for more than accumulated 8 hours (adj.) per occupied period for at least 3 (adj.) consecutive occupied periods.
10. Variable Frequency Drives shall be connected to the BAS to monitor, display, trend and report the following points:
    a. Speed output
    b. Hand/Auto selection indication
    c. Operating hours
    d. Faults

3.04 AHU-3 – DATA AQUISITION ROOM UNIT – SEQUENCE OF OPERATION

A. General description

1. System consists of recirculating variable volume computer room air handling (CRAH) unit, self-contained unit, upflow air delivery with filters, chilled water cooling coil and control valve, electric reheat, infrared humidifier, supply fan, and integral operating and safety controls.
2. Control components include integral temperature and humidity sensors and high temp stat.
3. All system controls shall be from the integral local controller. Unit shall be monitored by Metasys central console via BACnet IP.

B. Start-up and general controls (all starter H-0-A switches in "auto")

1. Air handling unit supply fan shall start upon manual or programmed start command from its local controller.
2. Integral space temperature sensor shall modulate the waterflow through the 2-way chilled water control valve (n.c.) to maintain 85ºf setpoint (adjustable).
3. Integral space temperature sensor shall operate the electric reheat through various stages of heating to maintain 68ºf setpoint (adjustable).
4. Integral humidity sensor shall operate the infrared humidifier to maintain 20% relative humidity setpoint (adjustable).
5. Shutdown of the system supply fan for any reason, including manual shutdown, shall cause all interlocked equipment, dampers, and valves to return to their "normal" positions.

C. Off-normal and alarm conditions

1. The high temperature sensor provided with the unit shall shut down the unit upon sensing high temperature setpoint of 90ºf (adjustable trial initial) at the return airstream.
2. UL-listed, electronically supervised air duct smoke detectors in the supply and return air furnished by Division 16.
3. Alarm conditions at the duct detector or building fire alarm panel shall de-energize all system fans/equipment and return dampers and valves to their "normal" positions.
4. Alarms shall produce an audio-visual signal at the metasys control console and shall require a manual reset to clear.
5. Filter Differential Pressure Monitor exceeds a user defined limit (adj.).

3.05 AHU-4 / DF-4 – HIGH BAY AREA – SEQUENCE OF OPERATION

A. Sequence shall be similar to that indicated for AHU-1 with the following differences:

1. The initial occupied cooling setpoint will be 78°F.
2. Deadband temperature range during occupied mode shall be 70°F to 75°F.
3. Unoccupied space temperature setpoints shall be 60°F (ADJ) heating and 85°F cooling.
4. Modulate the relief damper to control building and space pressurization. Provide one pressure sensor to measure between the High Bay Area and the lower level space below (control to 0.02” WC (ADJ) > than lower level). Locate the DP sensor associated with the lower level at a readily accessible location within the High Bay Area. Also provide a “building pressure” sensor to measure between the Temporary Machine Shop Area 105a and outdoors (control to 0.1 WC (ADJ) > than outdoors). Modulate the relief damper to maintain the more stringent of the signals from both sensors.
    a. If the relief damper is commanded closed by the pressure control AND the economizer is operating at minimum OA AND the building pressure is still below the setpoint, modulate the minimum OA damper open up to a maximum of 20% design supply air flow.

3.06 AHU-5 / DF -5 – PLANNING / ENTRY SPACES – SEQUENCE OF OPERATION

A. Sequence shall be similar to that indicated for AHU-1 with the following differences:

1. Experimental Mode is not required.
2. The initial occupied cooling setpoint will be 78°F.
3. Deadband temperature range during occupied mode shall be 70°F to 75°F.
4. Unoccupied space temperature setpoints shall be 60°F (ADJ) heating and 85°F cooling.
5. AHU-5 system does not include a relief damper / hood. Relief from AHU-5 areas shall be transferred out through the High Bay Area relief.

6. AHU-5 does not include an independent minimum OA damper. Minimum OA position is to be set at the main OA damper based on air balancing measurements. Provide a space temperature sensor in both the Planning Room 110 and the Entry 101. Initial setting shall include space temperature control based on the thermostat located in Planning Room 110. Provide programming to allow the user to select means of control from any of the following choices:
    a. Control from Planning Room 110, monitoring only at Entry 101.
    b. Control from Entry 101, monitoring only at Planning Room 110.
    c. Control based on the average of both Planning Room 110 and Entry 101.

3.07 RTU-1 / DH-1 – PRODUCTION SOLENOID AREA

A. RTU-1 is a grade mounted, 100% OA, single zone, packaged air conditioning unit with modulating gas heating, DX cooling and modulating hot gas reheat. RTU-1 shall be scheduled to operate continuously. Dehumidification unit DH-1 shall cycle based on a call for dehumidification.

B. Shutdown of the system supply fan for any reason, including manual shutdown, shall cause interlocked equipment, dampers, and valves to return to their “normal” positions. Outside air dampers shall close.

C. Temperature and humidity controls and sensors that are not factory installed with the unit shall be rated for use in the outdoor environment or shall be located outdoors in a weatherproof NEMA 4 enclosures. RTU-1 shall be provided with factory installed and tested sensors (outdoor air temperature sensor, discharge air temperature sensor) and field installed sensor (Humidity sensor). Provide all other sensors required for RTU/DH system operation and monitoring, 2 sets of temperature and humidity sensors (TTa, MTa, TTb, MTb). Provide all other sensors required for interface with BAS per Input/Output table.

    1. The final goal is to achieve no more than 38°F dewpoint (ADJ) as calculated from output from TTa & MTa or (as read from a dewpoint sensor at point a) and supply air temperature of 62-68°F (ADJ) as sensed at TTb, (except during RTU’s “fan-only non-dehumidification” operation where a temperature range equivalent to the outdoor air temperature 48-65F ADJ is expected). A reading from TTb & MTb will be used an additional secondary dewpoint for monitoring.
    2. RTU operation by its integral controller is based on outside air condition to maintain discharge air setpoints. RTU changeover is based on its outside air temperature and dewpoint. The unit state will change from cooling, fan only, or heating based on the change over heating and cooling setpoints. All setpoint settings are adjustable at the unit controller
        a) Heating state on at OAT<49 F to maintain DAT 62F
        b) Cooling state on at OAT>65 F to maintain DAT close to 48F
        c) Fan only operation at OAT between 48 and 65F
        d) Dehumidification reheat at OAT dewpoint above 38F to maintain DAT close to 48F.

3. In cooling mode, the RTU unit capacity will modulate the variable speed compressor or digital scroll compressor to maintain the unit cooling discharge set point at close to 48F (adjustable)
4. In heating mode, the modulating gas heat will be modulated by the unit controller to maintain the heating DAT setpoint (62F adjustable). The gas burner shall be capable of 10% minimum fire capacity.
5. RTU dehumidification hot gas reheat is activated when the outdoor air dewpoint, as sensed by its humidity sensor, is above 38F dewpoint. Upon activation, the compressor will energize to a capacity to maintain a leaving coil temperature while modulating the capacity of the hot gas reheat coil to maintain a final unit discharge air temperature as close to 48F as possible. The minimum leaving coil temperature, cooling DAT setpoint and humidity activation set points are all adjustable at the unit controller.RTU-1 shall operate at reduced coil leaving temperature in conjunction with dx hot gas reheat when required for dehumidification purposes. The unit's controls shall modulate the dx refrigeration and the unit's hot gas reheat coil as appropriate to maintain the supply air temperature and humidity setpoints.
6. The condenser head pressure will be monitored by the unit controller to maintain head pressure and the compressor operating envelope at all times to avoid high head pressure trips on high load days. The unit controller will continually monitor the suction and discharge pressure and temperature conditions during compressor operation. The unit will modulate the compressor, condenser head pressure, and electronic expansion valve to maintain a safe compressor operating conditions to add reliability, and limit unit shutdown during high head pressure or low suction conditions on design day operation
7. The dehumidification unit, DH-1, shall be activated indepently when dewpoint as sensed at point A, (by TTa & MTa, or dewpoint sensor), is above 38F. The DH-1 fan, desiccant wheel, and regeneration shall run continuously until the dew point setpoint being sensed at point a is satisfied.
8. The RTU unit controller shall interface with BAS. Display the following values at the BAS thru RTU controller and separate controller:
    a. Temperature at TTa, RH at MTa, dew point as calculated from TTa & MTa, or dewpoint reading directly from a dewpoint sensor.
    b. Temperature at TTb, RH at MTb, dew point as calculated from TTb & MTb.
    c. RTU-1 discharge air DAT, outdoor air temperature, dewpoint and flow readings, high DAT, low DAT, RAT sensor problem, OAT sensor problem, DAT sensor fault, EFT/LCT sensor problem, RAT sensor problem, dirty filter alarm, fan status.

D. Energize an identified "low limit" alarm at the BAS, de-energize all system fans/equipment and return all dampers their indicated "normal" positions upon supply air temperature (TTb) drop below 38°F (ADJ) lasting a continuous duration of 2 minutes (adjustable trial initial).

E. Across unit's filter bank provide Dwyer dual set point photohelic gauge with tamper proof setting and weatherproof housing. Switch shall energize an identified "dirty filter" warning alarm at the BAS upon sensing filter pressure drop in excess

of 0.75” w.c. (ADJ). Permanently label gauges with purpose and normal operating range.

F. Provide a differential current sensor across the DH-1 to operate in conjunction with a timer and start signal to activate an identified “dehumidification unit failure” alarm at the BAS upon sensing abnormal unit flow failure lasting a continuous duration of 60 seconds (adjustable trial initial).

3.08 OXYGEN DEFFICIENCY HAZARD PURGE ODH-MUA1 / ODH-E1 (ODH-MUA2 / ODH-E2 SIMILAR)

A. MUA fans and exhaust fans will start upon receipt of a 24 V DC signal from an oxygen depletion sensor provided by FNAL. AHU-2 and RF-2 shall stop upon activation of ODH-MUA2 / ODH-E2 and OA Damper shall open

B. Fans will run continuously until the alarm is cleared, and the ODH system has reset.

C. Hard wire all controls to start the ODH systems. Provide all relays, transformers, etc. as required. Enable MUA integral temperature control system upon starting of MUA supply fan.

D. Interlock the motorized dampers at the MUA unit inlet to open with operation of the fans. Stage the gas furnace based on outside air temperature. 1st stage on at outdoor temperatures below 50°F (ADJ) and both stages on at outdoor temperatures below 10°F (ADJ).

E. Do not include any low temperature cut out. When activated, the MUA supply fan shall run even with failure of the heating section.

F. BAS shall monitor ODH system activation, the status of all fans through current sensing, alarms, the damper positions through the use of end switches, and supply system discharge air temperatures.

3.09 OXYGEN DEFFICIENCY HAZARD PURGE EXHAUST ODH-E3 (SOLENOID AND POWER SUPPLY ROOM)

A. Fan will start upon receipt of a 24 V DC signal from an oxygen depletion sensor provided by FNAL. AHU-1 shall stop upon activation of ODH-E3.

B. Fans will run continuously until the alarm is cleared, and the ODH system has reset.

C. Make up air for the purge fans will enter the space though louvers located low on an outside wall. Interlock the motorized dampers at each louver to open with operation of the fan.

D. Hard wire all controls associated with the ODH systems. Provide all relays, transformers, etc. as required.

E. BAS shall monitor ODH system activation, the status of all fans through current sensing, alarms, and the damper positions through the use of end switches.

3.10 AC-1 / CU-1 – ELEVATOR RM AC

A. Wall mounted thermostat shall enable split system, dx cooling unit upon rise in space temperature above 85 deg f (ADJ). AC unit includes integral control transformer and wall thermostat is being furnished by the ac unit mfgr.

B. Provide room sensor and monitor through BAS. Initiate alarm at BAS upon sensing of space temperature > 90 deg f (ADJ).

3.11 VENTILATION SUPPLY FAN SF-1 (MECHANICAL ROOM)

A. Ventilation fan in shall be capable of manual operation

B. Ventilation fan shall start on a rise in space temperature above the 80°F (ADJ) setpoint as sensed by a temperature transmitter located in the space.

C. On a drop in temperature, the reverse shall occur.

D. During fan operation, air shall be relieved from room through roof mounted hood with non-motorized gravity relief damper.

3.12 TOILET / JANITOR’S CLOSET EXHAUST FANS

A. Toilet Room and Janitor’s Closet Exhaust Fans will be started on a time cycle (ADJ) through the BAS.

3.13 HIGH BAY AND MECHANICAL ROOM UNIT HEATERS

A. On a call for heating – temperature below the 68°F (ADJ) setpoint – the room thermostat shall cause the gas fired unit heater to be enabled. The fan shall run continuously and the gas burners shall cycle to maintain the room setpoint temperature.

3.14 MISCELLANEOUS ELECTRIC HEATERS

A. Integral thermostat shall cycle fan and stage heating element to maintain 68°F space temperature (adj). No bas interface is required.

B. Provide wall mounted thermostats for control of CUH-1 and CUH-2.

3.15 MONITORING OF MISCELLANEOUS EQUIPMENT

A. Gas meter: BAS shall monitor gas consumption, provide dynamic reading and record daily and monthly consumption totals. “Day of month” for monthly totals to be adjustable.

B. Water meter: BAS shall monitor water consumption, provide dynamic reading and record daily and monthly consumption totals. “Day of month” for monthly totals to be adjustable.

C. Electric meter: Power Logic shall monitor electric consumption, provide dynamic reading and record daily and monthly consumption totals. “Day of month” for monthly totals to be adjustable.

D. Glycol chilled water make up water system GF-1: The glycol make up water system includes a 55 gallon storage tank that requires manual feed of water to ensure that the proper glycol mixture is maintained. Initiate alarm at BAS upon detection of low level in storage tank.

E. Sump Pump SP-1 (SP-2 similar): BAS shall monitor pump status, amps, control panel temperature, alarm for high level and for loss of power. Initiate non-critical alarm upon continuous operation for a period greater than 60 minutes (ADJ).

END OF SECTION 15940

SECTION 15950 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.
2. Balancing Hydronic Piping Systems:
   a. Variable-flow hydronic systems.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 INFORMATIONAL SUBMITTALS

A. Certified TAB reports.

B. Sample report forms.

C. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Owner.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that penetrations in plenum walls are sealed and fire-stopped if required.

E. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and

Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 15086 "Duct Insulation," Section 15087 "HVAC Equipment Insulation," and Section 15088 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 15815 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
2. Measure fan static pressures as follows to determine actual static pressure:
   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Report the cleanliness status of filters and the time static pressures are measured.
4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance. At completion of project, all belt driven fans are to utilized fixed pitch pulleys. Determine sizes required for replacement pulleys where required. Install replacement pulleys and confirm that design airflows are achieved.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

E. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

1. Systems AHU-1, 2, 4 & 5 include minimum OA dampers with integral air measuring capabilities. Make airflow measurements as required for temperature control contractor to achieve proper calibration of airflow measuring.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Variable air volume systems on this project are all single zone type. Follow procedures indicated for Constant Air Volume Systems and also include the following.
1. At completion of project, all belt driven fans are to utilized fixed pitch pulleys. Determine sizes required for replacement pulleys where

required. Install replacement pulleys and confirm that design airflows are achieved at 60 Hz.

2. Develop fan tracking curve for AHU-2 / RF-2 based on (3) measurements at different supply fan speeds (30 Hz, 45 Hz, 60 Hz). Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner and comply with requirements in Section 15185 "Hydronic Pumps."
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-

capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Check settings and operation of safety and relief valves. Record settings.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.

2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

3.13 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to plus 10 percent .
2. Air Outlets and Inlets: Plus 10 or minus 5 percent.
3. Heating-Water Flow Rate: Plus 10 or minus 5 percent.
4. Cooling-Water Flow Rate: Plus 10 or minus 5 percent.

3.14 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.

c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):
a. Total air flow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Filter static-pressure differential in inches wg (Pa).
f. Cooling-coil static-pressure differential in inches wg (Pa).
g. Heating-coil static-pressure differential in inches wg (Pa).
h. Outdoor airflow in cfm (L/s).
i. Return airflow in cfm (L/s).
j. Outdoor-air damper position.
k. Return-air damper position.

F. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h (kW).

2. Test Data (Indicated and Actual Values):
a. Total air flow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btu/h (kW).
i. High-fire fuel input in Btu/h (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).
l. Operating set point in Btu/h (kW).
m. Heating value of fuel in Btu/h (kW).

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.

g. Rated amperage.
h. Air flow rate in cfm (L/s).
i. Face area in sq. ft. (sq. m).
j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Entering-air temperature in deg F (deg C).
d. Leaving-air temperature in deg F (deg C).
e. Voltage at each connection.
f. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.

2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
a. System and air-handling-unit number.
b. Location and zone.
c. Duct size in inches (mm).
d. Duct area in sq. ft. (sq. m).
e. Indicated air flow rate in cfm (L/s).
f. Indicated velocity in fpm (m/s).
g. Actual air flow rate in cfm (L/s).
h. Actual average velocity in fpm (m/s).

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
a. Unit identification.
b. Location.

c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm (L/s).
g. Water pressure differential in feet of head or psig (kPa).
h. Pump rpm.
i. Impeller diameter in inches (mm).
j. Motor make and frame size.
k. Motor horsepower and rpm.
l. Voltage at each connection.
m. Amperage for each phase.
n. Full-load amperage and service factor.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig (kPa).
b. Pump shutoff pressure in feet of head or psig (kPa).
c. Actual impeller size in inches (mm).
d. Full-open flow rate in gpm (L/s).
e. Full-open pressure in feet of head or psig (kPa).
f. Final discharge pressure in feet of head or psig (kPa).
g. Final suction pressure in feet of head or psig (kPa).
h. Final total pressure in feet of head or psig (kPa).
i. Final water flow rate in gpm (L/s).
j. Voltage at each connection.
k. Amperage for each phase.

K. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.15 INSPECTIONS

A. Final Inspection:

1. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the Owner.
2. The Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

B. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

C. Prepare test and inspection reports.

END OF SECTION 15950

SECTION 15975 - DIGITAL CONTROL EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control Equipment.

B. Software.

1.02 RELATED SECTIONS

A. See Section 15940 for Sequence of Operations.

1.03 REFERENCES

A. ASME MC85.1 - Terminology for Automatic Control.

B. NEMA EMC1 - Energy Management Systems Definitions.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NFPA 70 - National Electrical Code.

E. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

1.04 SYSTEM DESCRIPTION

A. Provide controls for new equipment as an extension of the Johnson Metasy's Building Automation System (BAS). At a minimum, provide all control points necessary to accomplish the sequence of operation. Contractor shall provide all transformers, switches, etc. necessary for a complete operating system.

B. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to Building Management System.

C. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

D. Include computer software and hardware, operator input/output devices, control units, sensors, control devices, actuators.

E. Provide control systems consisting of controllers, sensors, thermostats, control valves, dampers, indicating devices, interface equipment, control wiring, conduits, relays, transformers, actuators and other apparatus and accessories required to operate mechanical systems, and to perform

functions specified. Provide all miscellaneous power wiring, extended from the nearest appropriate power source, as required for control panels, controllers, transformers, actuators, etc. Comply with division 26 for all electrical work.

1.05 SUBMITTALS FOR REVIEW

A. Product Data: Provide data for each system component and software module

B. Shop Drawings:

1. List connected data points, including connected control unit and input device. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
2. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
3. Indicate description and sequence of operation of operating, user, and application software.

1.06 SUBMITTALS FOR INFORMATION

A. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

1.07 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.
2. Include data specified in "Submittals" in final "Record Documents" form.

B. Operation and Maintenance Data:

1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

C. Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

1.08 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

1.09 ISO-9001

A. The manufacturer of the Facility Management System shall provide documentation supporting compliance with ISO-9001 (Model of Quality Assurance in Design/Development, Production, Installation, and Servicing). Product Literature provided by the FMS manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar. Manufacturers delivering products that do not comply with the ISO-9001 certification requirement shall provide the following information to assure that quality systems are in place which are equivalent to the ISO-9001 standard:

1. Marketing Specification Standards
2. Design File Standards
3. Manufacturing Test Standards
4. Calibration Standards
5. Quality System Standards
6. Quality System Procedures
7. Documented management commitment that all employees participate in quality programs
8. Training Procedures.
9. Methods by which corrective actions are taken for problems identified within the factory process.

PART 2 PRODUCTS

2.01 MANUFACTURERS/INSTALLERS

A. Manufacturers:

1. Johnson Controls, Inc.

B. Installers:

1. Applied Controls, Inc.
2. Johnson Controls, Inc.

2.02 DDC CONTROLS

A. Unit Controllers:

1. Programmable control module shall be pre-programmed prior to jobsite delivery for the applicable sequence of operation.

2.03 CONTROL UNITS

A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.

B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger. This battery backup shall only be used to retain memory in the controller, not to keep it functioning.

C. Control Units Functions:

1. Monitor or control each input/output point.
2. Completely independent with hardware clock/calendar and software to maintain control independently.
3. Acquire, process, and transfer information to operator station or other control units on network.
4. Accept, process, and execute commands from other control unit's or devices or operator stations.
5. Access both data base and control functions simultaneously.
6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
7. Perform in stand-alone mode: Start/stop, duty cycling, automatic temperature control, demand control via a sliding window, predictive algorithm, event initiated control, calculated point, scanning and alarm processing, full direct digital control, trend logging, global communications, maintenance scheduling.
8. Global Communications: Broadcast point data onto network, making that information available to all other system control units.
9. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.

D. Input/Output Capability: Discrete/digital input (contact status), discrete/digital output, analog input, analog output, pulse input (5 pulses/second), pulse output (0-655 seconds in duration with 0.01 second resolution).

E. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Install control units with minimum 30 percent spare capacity.

F. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

G. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.

H. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment.

I. Local display and adjustment panel: Portable or Integral to control unit, containing digital display, and numerical keyboard. Display and adjust:

input/output point information and status, controller set points, controller tuning constants, program execution times, high and low limit values, limit differential, set/display date and time, control outputs connected to the network, automatic control outputs, perform control unit diagnostic testing, points in "Test" mode.

2.04 LOCAL AREA NETWORKS (LAN):

A. Provide communication between network control units over existing N2 local area network (LAN). System must be capable of supporting Ethernet LAN between network control units.

B. LAN Capacity: Not less than 60 stations or nodes.

C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

D. LAN Data Speed: Minimum 10 MB as an Ethernet.

E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

H. Secondary network N2 to operate at 9.6 KB.

2.05 OPERATING SYSTEM SOFTWARE

A. Provide input/output capability from operator station.

B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.

C. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match.

D. Provide dynamic color graphic displays for each system / equipment listed on point charts. Include each mechanical system, building floor plan, and control device depicted by point-and-click graphics. Display all setpoints, monitored points, alarms and all other parameters as identified in the point charts, piping diagrams, control diagrams and operating sequences.

E. Provide operator station.

F. Provide alarm processing.

G. Provide event processing.

H. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.

I. Provide message display.

J. Provide reports.

K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

L. Provide data collection.

M. Graphic Display: Support graphic development on work station with software features.

N. Provide maintenance management.

O. Provide advisories.

2.06 LOAD CONTROL PROGRAMS

A. General: Support inch-pounds and S.I. metric units of measurement.

B. Provide demand limiting.

C. Provide duty cycling.

D. Provide automatic time scheduling.

E. Provide start/stop time optimization.

F. Provide night setback/setup program.

G. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.

H. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.

I. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.

J. Provide fine tuning direct digital control PID or floating loops.

K. Provide trend logging.

2.07 HVAC CONTROL PROGRAMS

A. Support Inch-pounds and S.I. metric units of measurement. Identify each HVAC Control system.

B. Provide optimal run time.

C. Provide supply air reset.

D. Provide enthalpy switchover.

2.08 PROGRAMMING APPLICATION FEATURES

A. Provide trend logs.

B. Provide alarm messages.

C. Provide weekly scheduling.

D. Provide event interlocking.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices and wiring is installed prior to installation proceeding.

3.02 INSTALLATION

A. Install control units and other hardware in position on permanent walls were not subject to excessive vibration.

B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to drawings.

C. Electrical material and installation shall be in accordance with appropriate requirements of Division 16.

3.03 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems.

B. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

C. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 16 hours.

END OF SECTION

SECTION 15980 - INSTRUMENTS AND CONTROL ELEMENTS

PART 1. GENERAL

1.01 SECTION INCLUDES

A. Control Panels.

B. Automatic Dampers.

C. Damper Operators.

D. Input/Output Sensors.

E. Thermostats.

F. BTU meters.

G. Control Valves.

H. Miscellaneous Accessories.

1.02 RELATED SECTIONS

A. Section 15940 - Sequence of Operation.

B. Section 15975 – Digital Control Equipment.

1.03 REFERENCES

C. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

E. ASTM B32 - Solder Metal.

F. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

G. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.

H. NEMA DC 3 - Low-Voltage Room Thermostats.

I. NFPA 70 - National Electrical Code.

J. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

1.04 SUBMITTALS FOR REVIEW

A. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.

B. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

1.05 SUBMITTALS FOR INFORMATION

A. Manufacturer's Instructions: Provide for all manufactured components.

1.06 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

B. Revise shop drawings to reflect actual installation and operating sequences.

C. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

D. Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

1.07 WARRANTY

A. Correct defective Work within a one year period after Substantial Completion.

1.08 QUALITY ASSURANCE

A. Johnson Controls, Inc.

1.09 EXTRA MATERIALS

A. Provide two of each type of thermostat and exposed sensor.

PART 2. PRODUCTS

2.01 CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.

B. NEMA 250, general purpose utility enclosures with enameled finished face panel.

C. Provide common keying for all panels.

D. No exposed voltages greater than 50 VAC shall be in control panels with controllers. If controllers are located within mechanical equipment panels, voltages greater than 50 VAC shall be covered and “finger protected”. “Finger protected” is defined as protection against a standard jointed finger (length 80mm and diameter 12mm) from contacting any live part.

2.02 DAMPERS

A. Performance: Test in accordance with AMCA 500.

B. Frames: Galvanized steel, welded or riveted with corner reinforcement.

C. Blades: Galvanized steel, maximum blade size 6” wide, 48” long, attached to minimum 1/2” shafts with set screws.

D. Blade Seals: Synthetic elastomeric or Neoprene mechanically attached, field replaceable.

E. Jamb Seals: Spring stainless steel.

F. Shaft Bearings: Graphite impregnated nylon sleeve, with thrust washers at bearings or lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.

G. Linkage Bearings: Graphite impregnated nylon.

H. Leakage: Less than 2 percent based on approach velocity of 2000 ft/min and 4” w.g.

I. Maximum Pressure Differential: 6” w.g.

J. Temperature Limits: -40 to 200°F.

2.03 DAMPER OPERATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

B. Electric Operators:

1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch minimum position potentiometer and 24 V dc, 24 va transformer.

2. Manufacturer: Belimo, / Johnson Controls.

C. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide one damper operator for maximum 25 sq ft damper section.

2.04 INPUT/OUTPUT SENSORS

A. Temperature:

1. Resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70°F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.

2. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 8’ or 16’ as required.

3. Insertion elements for liquids shall be with stainless steel socket with minimum insertion length of 2-1/2”.

4. Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.

B. Static Pressure Sensors:

1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.

2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100°F.

3. Accuracy: One percent of full scale with repeatability 0.3 percent.

4. Output: 0 - 10 vdc or 4 – 20 ma.

C. Equipment Operation Sensors:

1. Status Inputs for Fans/Pumps: Differential pressure switch with adjustable range of 0 to 5 inches w.g. (0 to 1250 Pa).

2. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

D. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.

2.05 THERMOSTATS

A. Room Temperature Sensors.

1. Room sensors shall be constructed for either surface or wall box mounting.

2. Room sensors shall have the following options when specified:

a. Setpoint reset slide switch providing a ± 3° (adjustable) range.

b. Analog thermometer.

B. Line Voltage Thermostats:

1. Integral manual On/Off/Auto selector switch, single or two pole as required.

2. Dead band: Maximum 2°F.

3. Cover: Locking with concealed setpoint, without thermometer.

4. Rating: Motor load.

C. Room Thermostat Accessories:

1. Thermostat Covers: Brushed aluminum or clear cover.

2. Insulating Bases: For thermostats located on exterior walls.

3. Thermostat Guards: Metal mounted on separate base.

4. Adjusting Key: As required for device.

D. Immersion Thermostat:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

E. Airstream Thermostats:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.

2. Averaging service remote bulb element: 20’.

F. Outside Air Sensors.

1. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

2. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.

3. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperature.

G. Duct Mount Sensors.

1. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

H. Averaging Sensors.

1. For ductwork greater in any dimension the 48” and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

2. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12’ long segment.

3. Capillary supports at the sides of the duct shall be provided to support the sensing strip.

2.06 BTU METERS

A. Turbine Flowmeters:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. E-Mon; Energy Monitoring Products – System 10 with F-1100 Flow Meter.

2. Description: BTU meter with flow sensor, temperature sensors and indicator.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

4. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute (liters per second).

a. Design: Insertion turbine flow meter for measuring electrically conductive water based liquids.

b. Construction: Aluminum body, with nickel plated brass wetted components.

c. Minimum Pressure Rating: 150 psig (1035 kPa).

d. Minimum Temperature Rating: 180°F (82°C).

5. Temperature Sensors: Insertion-type transducer.

6. Indicator: Wall mounted with LCD display and BACnet MSTP interface.

7. Accuracy: Plus or minus 1/2 percent of the calibrated flow rate, plus or minus 2 percent over an extended 50:1 turndown range.

8. Display: Shows rate of flow, with register to indicate total volume in gallons; total energy, energy flow rate, supply temperature and return temperature.

9. Communications: BACnet MSTP serial communications to transmit rate of flow, energy flow rate, supply temperature and return temperature.

10. Operating Instructions: Include complete instructions with each BTU meter.

2.07 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back seating capacity repackable under pressure.

2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.

b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

c. Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate or the following:

1) Two Position: Line size.

2) Modulating: Either the value specified above or the load pressure drop, whichever is more.

d. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

e. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

2.08 TRANSMITTERS

A. Differential Pressure Transmitters.

1. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

2. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

3. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shutoff valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.

4. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible

B. Low Differential Water Pressure Applications (0" - 20" w.c.).

1. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.

2. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

a. 01-20" w.c. input differential pressure range.

b. 4-20 mA output.

c. Maintain accuracy up to 20 to 1 ratio turndown.

d. Reference Accuracy: +0.2 percent of full span.

D. Low Differential Air Pressure Applications (0" to 5" w.c.).

1. The differential pressure transmitter shall be of industry quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

2. The differential pressure transmitter shall have non-interactive zero and span adjustment that are adjustable from the outside cover and meet the following performance specifications:

a. (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)

b. 4-20 mA output.

c. Maintain accuracy up to 20 to 1 ratio turndown.

d. Reference Accuracy: +.02 percent of full span.

E. Temperature Transmitters:

1. Manufacturer: Weiss – Vari-Angle Self-Indicating Temperature Transmitters Model DVUT.

2. One pipe, directly proportional output signal to measured variable, linearity within 1 percent of reading or 1°F, whichever is greater.

3. Integral light powered LCD readout.

4. Insertion elements for liquids shall be with stainless steel socket with minimum insertion length of 2-1/2”.

F. Humidity Sensors: Bulk polymer sensor element.

1. Available Manufacturers:

a. BEC Controls Corporation.

b. General Eastern Instruments.

c. MAMAC Systems, Inc.

d. ROTRONIC Instrument Corp.

e. TCS/Basys Controls.

f. Vaisala.

2. Accuracy: 2 percent full range with linear output.

3. Duct Sensor: 0 to 100 percent relative humidity range with element guard and with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185°F (minus 30 to plus 85°C).

2.09 STATUS AND SAFETY SWITCHES

A. General Requirements.

1. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal conditions occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

B. Current Sensing Switches.

1. The current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept overcurrent up to twice its trip point range.

2. Current sensing switches shall be used for run status for fans, over-current up to twice its trip point range.

3. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

C. Air Filter Status Switches

1. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120 VAC.

2. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

3. Provide appropriate scale range and differential adjustment for intended service.

D. Air Pressure Safety Switches

1. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120 VAC.

2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

PART 3. EXECUTION

3.01 EXAMINATION

A. Verify that systems are ready to receive work.

B. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units.

D. Ensure installation of components is complementary to installation of similar components.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches.

C. Mount freeze protection thermostats using flanges and element holders.

D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors on shaded north exposure.

E. Provide separable sockets for liquids and flanges for air bulb elements.

F. Provide guards on thermostats in entrances, corridors, other public areas, and where indicated.

G. Provide mixing dampers of opposed blade construction arranged to mix streams

H. Provide isolation (two position) dampers of parallel blade construction.

I. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

J. Install flow meters through full port ball valve connection to main. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters. Connect thermal-energy meter transmitters to meters.

K. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

L. After installation, calibrate meters according to manufacturer's written instructions.

END OF SECTION

SECTION 15995 - COMMISSIONING OF HVAC SYSTEMS

PART 1. GENERAL

1.01 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with assurance that the mechanical systems have been installed according to the contract documents, and operate within the performance guidelines set out in the design drawings, sequence of operations, these specifications and related specifications. The contractor shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. The commissioning process does not take away or reduce the responsibility of the installing contractors to provide a finished product, installed and fully functional in accordance with the contract documents. The contractor in coordination with the Fermilab construction coordinator and/or the laboratory's representative shall plan all commissioning activities in conjunction with the construction manager, subcontractors, manufacturers and equipment suppliers. The General Contractor, Mechanical Contractor, all Division 15 sub-contractors, and the Electrical Contractor shall be responsible for cooperating, and coordinating their work, with the general contractor. They shall also be responsible for carrying out all the physical activities required for installation of components and systems, and operating them during the commissioning process as required in this Section.

B. Provide all materials and labor to perform HVAC system commissioning which include the following:

1. System Verification or Contractor Pre-Inspection Checklist (CPI).

2. Functional Performance Test (FPT).

3. Controls Point to Point Check.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions; Exhibit-A; and other applicable specifications apply to work of this section.

1.03 REFERENCES

A. Associated Air Balance Council Commissioning Guideline

PART 2. PRODUCTS

2.01 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

HVAC equipment and systems and Controls installed under this contract are to be inspected, tested, signed off as complete and operational, and operated for commissioning agency verification as described in Part 3 of this Section. This includes, but is not necessarily limited to the work listed for each following system;

A. AHU: all air handlers, including DOAS or MUA.

B. EF & ODH-E: all exhaust fans.

C. RF: return fan.

D. SF: supply fan.

E. P: glycol pumps and glycol system accessories.

F. HX: all heat exchangers.

G. DF: all duct furnaces.

H. CF: all ceiling fans.

I. GUH: all unit heaters.

J. Electric heaters.

K. Meters.

L. Domestic water systems.

M. Ejector pumps.

N. Lighting Controls.

2.02 System Verification Checklists (SVC) or Contractor Pre-Inspection (CPI) forms. Develop, Review, Coordinate, Schedule, Perform, Witness, and Submit System Verification Checklist / Contractor Pre-Inspection checklist, for the equipment and systems to be commissioned using sample Commissioning Plan as a guide.

2.03 Functional Performance Test (FPT) Checklists Forms. Review, Coordinate, Schedule, perform, witness, and submit Functional Performance Test which include Controls Verifications, for the HVAC system and BAS/Controls using sample Commissioning Plan as a guide.

PART 4. EXECUTION

3.01 The contractor shall

A. Plan, organize and implement the commissioning process as specified herein;

B. Coordinate commissioning activities among all contractors, sub-trades and suppliers;

C. Monitor system verification checks, and ensure the results are documented as the checks are done;

D. Monitor controls point-to-point checks done by the controls contractor, and ensure the results documented as the checks are done;

E. Observe all start-ups and initial system operations tests and checks;

F. Direct the contractors to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;

G. Witness all functional performance tests and document the results;

H. Prepare and submit a Commissioning Report which documents all checks and tests done throughout the Commissioning process, and the results obtained from each; and

I. Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated operating staff.

J. Shall facilitate communications among all contractors, owner and suppliers and other commissioning team members, and shall foster the necessary cooperative action.

3.02 Mechanical SubContractor's Responsibilities with regard to Commissioning. Mechanical sub-contractors and suppliers, shall cooperate in carrying out the HVAC commissioning process. In this context, the Mechanical Contractor shall:

A. Ensure the automatic temperature controls (ATC) subcontractor performs HVAC commissioning responsibilities as listed in 3.04.

B. Provide instruction and demonstrations for the Owner's designated operating staff, with the participation of qualified technicians from major equipment suppliers and the controls contractor.

C. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.

D. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, and water treatment as applicable.

E. Ensure participation of major equipment manufacturer in appropriate start-up, testing and training activities.

F. Attend HVAC commissioning meetings.

G. Notify the Construction Coordinator through the general contractor a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the Fermilab representative may witness system verifications, and equipment and system start-ups.

H. Provide sufficient personnel to assist as required during system verification and functional performance testing.

I. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.

J. Notify the Construction coordinator through their general contractor a minimum of two weeks in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.

K. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs.

L. Carry out performance checks to ensure that all equipment and systems fully functional and ready for Fermilab's representative to witness formal functional performance tests (FPTs).

M. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. Those responsible for deficient or incomplete work will be responsible for costs. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable subcontractors, carry out functional performance checks to confirm correct operation before applying to reschedule the FPTs for the system in question.

N. Prepare preliminary schedule for mechanical system orientation and inspections. O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment startup TAB, and task completion. Update schedule as appropriate throughout the construction period.

O. Conduct mechanical system orientation and inspection at the equipment placement completion stage.

P. Gather O&M data on all equipment, and assemble in binders as required by the commissioning specification for submission in accordance with Exhibit A.

Q. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions.

R. Provide written notification to the general contractor that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.

S. That the building control system is functioning to control mechanical equipment as specified.

3.03 TAB (Testing Adjusting and Balancing) subcontractor's Responsibilities with regard to Commissioning

A. Submit proposed TAB procedures for review and acceptance.

B. At the completion of the TAB work, submit the final TAB report to the general contractor, with copies to the Owner.

3.04 Controls (Automatic Temperature Controls- ATC) subcontractor's Responsibilities with regard to Commissioning

A. Include cost for commissioning requirements in the quoted price.

B. Review and confirm that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.

C. Review and confirm that proper safeties and interlocks are included in design.

1. Ensure the proper selection of sensor ranges, and include data with submittal

2. Clarify all questions concerning sequences of operation with the owner's control representative.

D. Provide the following submittals;

1. Hardware and software submittals.

2. Control panel construction shop drawings.

3. Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.

4. Narrative description of all control sequences for each piece of equipment controlled.

5. Logic diagrams showing the logic flow of all control sequences.

6. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.

7. A complete control language program listing including all software routines employed in operating the control system. Also provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and the functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.

8. Hardware operation and maintenance manuals.

9. Application software and project applications code manuals.

E. Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others.

F. Integrate installation and programming scheduling with construction and commissioning schedules.

G. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.

H. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.

I. Provide control system technician to assist during system verification and functional performance testing.

J. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.

3.05 Plumbing SubContractor's Responsibilities with regard to Commissioning. Plumbing sub-contractors and suppliers, shall cooperate in carrying out the plumbing commissioning process. In this context, the Plumbing Contractor shall:

A. Provide instruction and demonstrations for the Owner's designated operating staff, with the participation of qualified technicians from major equipment suppliers and the controls contractor.

B. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.

C. Ensure participation of major equipment manufacturer in appropriate start-up, testing and training activities.

D. Attend commissioning meetings.

E. Notify the Construction Coordinator through the general contractor a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the Fermilab representative may witness system verifications, and equipment and system start-ups.

F. Provide sufficient personnel to assist as required during system verification and functional performance testing.

G. Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.

H. Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs.

I. Carry out performance checks to ensure that all equipment and systems fully functional and ready for Fermilab's representative to witness formal functional performance tests (FPTs).

J. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. Those responsible for deficient or incomplete work will be responsible for costs. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable subcontractors, carry out functional performance checks to confirm correct operation before applying to reschedule the FPTs for the system in question.

K. Prepare preliminary schedule for plumbing system orientation and inspections. O&M manual submission, training sessions, pipe system testing, flushing and cleaning, equipment startup, and task completion. Update schedule as appropriate throughout the construction period.

L. Conduct plumbing system orientation and inspection at the equipment placement completion stage.

M. Gather O&M data on all equipment, and assemble in binders as required by the commissioning specification for submission in accordance with Exhibit A.

N. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions.

3.06 Electrical subcontractor's responsibilities with regard to Commissioning

A. Include cost for HVAC commissioning requirements in the quoted price.

B. Review design with respect to providing power to the HVAC equipment;

1. Verify that proper hardware specifications exist for functional performance and sequence of operation required by specification.

2. Verify that proper safeties and interlocks are included in the design of electrical connections for HVAC equipment.

C. Schedule work so that required electrical installations are completed, and systems verification checks and functional performance tests can be carried out on schedule.

D. Inspect, check and confirm in writing the proper installation and performance of all electrical services provided.

E. Provide electrical system technicians to assist during system verification and functional performance testing as required by the general contractor.

END OF SECTION 15995

SECTION 16010 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section includes the general work associated with General Electrical Requirements as well as the installation of electrical systems.

B. The drawings and specifications are meant to complement each other; however, in case of conflicts, the specifications shall govern, since they are intended to identify all materials and equipment required for the construction of the facility. Any deviation from the specifications or subcontract drawings shall be authorized by the Fermilab Construction Coordinator prior to purchase or installation.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 16015 – Electrical Requirements for Mechanical Equipment.

B. Section 16060 – Grounding and Bonding.

C. Section 16073 – Hangers and Supports for Electrical Systems

D. Section 16075 – Electrical Identification

E. Section 16080 – Electrical Testing and Inspection.

F. Section 16100 – Ductbank.

G. Section 16120 – Low Voltage Wire & Cable – 600-Volt.

H. Section 16125 – 15 kV Cable Installation

I. Section 16130– Raceways and Boxes.

J. Section 16140 – Wiring Devices.

K. Section 16145 – Lighting Control Devices.

L. Section 16410 – Enclosed Disconnect Switches and Circuit Breakers.

M. Section 16441 – Switchboards.

N. Section 16442 – Panelboards.

O. Section 16460 – Dry Type Transformers.

P. Section 16500 – Lighting Systems.

Q. Section 16570– Lighting Controls.

R. Section 16721– Fire Alarm System.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. ANSI (American National Standards Institute)

1. ANSI C2 (National Electrical Safety Code)

B. ICEA (Insulated Cable Engineers Association)

C. IEEE (Institute of Electrical and Electronics Engineers)

D. NEMA (National Electrical Manufacturers Association)

E. NETA (national Electrical Testing Association)

F. NFPA (National Fire Protection Association)

1. NFPA 70 (National Electric Code)

G. OSHA (Occupational Safety and Health Administration)

H. UL (Underwriters' Laboratories, Inc.)

1.04 SUBMITTALS: At least ten (10) days prior to the procurement of the equipment or material or installation thereof, and at least sixty (60) days after subcontract award, Subcontractor shall submit a paper copy & Excel spreadsheet listing all equipment and material proposed for the project. List shall set forth the Section page number, manufacturer's name, model number, size, non-standard accessories specified or required and any other information to identify each item. Submittal documentation shall be in accordance with Exhibit A, Section 12:

A. Throughout the progress of construction, keep a complete and detailed record of all deviations in the electrical installation from that indicated on the Drawings, specifications and/or shop drawings. At the completion of the project and prior to final payment this marked set of drawings shall be submitted to Fermilab Construction Coordinator.

1.05 OPERATION AND MAINTENANCE MANUALS

A. At the completion of the project, Subcontractor shall submit operating instructions and maintenance manuals. Submit model number, catalog information, technical data sheets, shop drawings, test reports, wiring

diagrams, parts lists and maintenance instructions where applicable for each of the following items of equipment:

1. Wiring Devices
2 Dry-Type Transformers
3. Switchboards
4. Panelboards
5. Disconnect Switches, Enclosed Circuit Breakers
6. Light Fixtures
7. Lighting Controls

B. Operation and Maintenance Manuals shall be bound in an indexed 3-ring binder.

1.06 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with the requirements of Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

C. Performance Guarantee:

1. Installation of electrical systems shall be completed to the satisfaction of Fermilab Construction Coordinator. Work performed by the Subcontractor judged not to be to the satisfaction of the Fermilab Construction Coordinator shall be corrected by the Subcontractor, at no additional cost to the Fermilab.
2. It shall be the sole responsibility of the Subcontractor that the electrical systems are installed to the satisfaction of Fermilab.
3. Subcontractor shall guarantee all equipment, material, and installation provided by Subcontractor to be free from defects.

PART 2 PRODUCTS

2.01 Except as designated as furnished by Others, Subcontractor shall furnish all supervision, labor, material, tools, equipment, testing devices, machinery, consumables and other items necessary for a complete and workable installation. All materials furnished by the Subcontractor shall be new and shall be subject to review and acceptance by the Fermilab Construction Coordinator.

2.02 Any apparatus, appliance, material or work not shown on drawings or indicated in the sections, but necessary to make the work complete and ready for operation shall be furnished, delivered and installed by Subcontractor, without additional expense to Fermilab.

PART 3 EXECUTION

3.01 COORDINATION WITH OTHER TRADES

A. Coordination shall include the checking and review of other discipline drawings to ensure that no conflicts exist in dimensions or location of equipment.

B. Subcontractor shall coordinate the installation of equipment with other trades and schedule work activities to complete the installation in an orderly fashion and to avoid rework.

C. Subcontractor shall attend meetings as scheduled by the Fermilab Construction Coordinator to facilitate an orderly and timely completion of the work.

3.02 EQUIPMENT AND MATERIAL PROTECTION

A. Receiving and Preparation of Equipment:

1. Subcontractor shall receive, unload, inspect, test and store all equipment and materials, whether furnished by the Subcontractor or furnished by Fermilab.
2. Subcontractor shall examine and inspect equipment and material upon receipt for shortages or damage. Subcontractor shall conduct any testing, as required, to establish the condition of the equipment upon receipt.
3. Unless a deficiency report is submitted in writing by the Subcontractor to the Fermilab Construction Coordinator, all equipment and material is assumed to be received in good condition, complete with all parts and components.
4. Subcontractor shall carefully close, repair, and restore shipping crates and boxes so as to maintain the equipment in clean, like new condition and to avoid loss of parts during storage.
5. Subcontractor shall carefully review installation/operations manuals and other instructions regarding protection of their equipment during storage and before operations.

B. Handling and Storage:

1. After equipment has been received and moved into the designated storage area, Subcontractor shall unpack each individual carton, visually inspect and check for correct and complete installation of all parts, components, equipment and associated devices in accordance with the manufacturer’s drawings. Protective packaging shall then be reinstalled following inspection and shall not be removed until the equipment is ready to be installed into its permanent location.
2. Subcontractor shall be solely responsible for storage and protection of equipment and materials from the time of receipt until final installation and acceptance of the Fermilab Construction Coordinator.

3. The type of storage and protection shall be determined from the manufacturer's instructions and specific instructions from Fermilab Construction Coordinator.
4. Maintenance requirements at the storage areas shall include the following:

    a. Access shall be controlled.
    b. Condition of the storage area shall be monitored so that lack of protection, such as loss of heat or weatherproof covering, is detected and corrected.
    c. Fire protection shall be compatible with materials stored and type of storage.
    d. Sources of contamination, such as rodents, flooding, eating and drinking in areas, shall be controlled.
    e. Storage areas shall be organized to maintain proper segregation and retrievability of material.

3.03 ELECTRICAL INSTALLATION REQUIREMENTS

A. The drawings indicate the general layout of the electrical systems, arrangement of feeders, circuits, outlets, switches, controls, panelboards, transformer, service equipment, fixtures and other work. Electrical plans are by nature diagrammatic.

B. Subcontractor shall bring to Fermilab's attention any discrepancies between the drawings and the "As-Constructed" conditions. Subcontractor shall not deviate from the drawings without written approval from the Fermilab Construction Coordinator

C. Subcontractor shall verify the location and method for connecting to each item of equipment.

D. Subcontractor shall install equipment and material in accordance with the Subcontract requirements. Materials or equipment improperly installed shall be removed and reinstalled to the satisfaction of Fermilab Construction Coordinator, at Subcontractor's expense.

E. Subcontractor shall be responsible for the assembly of any and all equipment shipping splits. Shipping splits improperly assembled or installed shall be re-assembled and reinstalled to the satisfaction of Fermilab Construction Coordinator, at Subcontractor's expense.

F. The architectural, structural, piping, and mechanical drawings and specifications are incorporated into this section by this reference.

3.04 TESTING AND PREPARATION FOR ENERGIZATION

A. Subcontractor shall perform inspection, testing and calibration of electrical equipment and systems in accordance with Section 16080: Electrical Testing and Inspection. All testing shall be performed to the satisfaction of

the Fermilab Construction Coordinator. All testing shall conform to the Fermilab ES&H Manual, Sections 5040 through 5047.

B. Subcontractor shall furnish all meters, instruments, tools, labor, supervision, etc. for all testing requirements. Testing forms are included as part of Section 16080: Electrical Testing and Inspection. Subcontractor shall furnish the completed testing forms to the Fermilab Construction Coordinator after each piece of equipment is tested.

C. Fermilab reserves the right to inspect and test any portion of the equipment and materials at any time during the installation process.

D. Prior to connection of equipment to the wiring system, Subcontractor shall verify that all wiring and connections are free from short circuits, open circuits and unintentional grounds. Subcontractor shall test the entire system in the presence of the Fermilab Construction Coordinator and verify that the entire electrical system is properly installed before energization of any portion of the electrical system.

E. Work on the electrical distribution system, where the system is energized or capable of being energized, shall be in accordance with Chapter 5042 of the Fermilab ES&H Manual. Such work may necessitate the generation and approval of an Electrical Hazard Analysis/Work Permit:

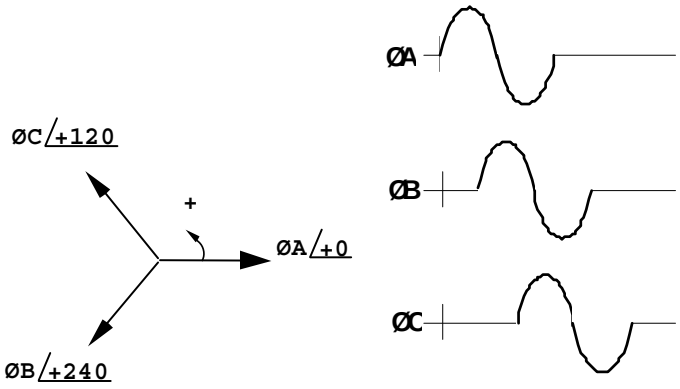
1 Subcontractor shall contact the Fermilab Construction Coordinator for the AC Electrical Power Distribution Safety bulletin and Permit To Work On Energized AC Electrical Construction Distribution Systems (Bulletin 5042) prior to working on energized electrical systems.

2. Hot work on the AC Electrical Distribution System by the Subcontractor shall not be permitted. Work on energized conductors where a circuit connection is closed or opened is considered as hot work. Measurement and testing of the parameters of an energized system, while subject to appropriate safety procedures and precautions, is not considered to be hot work.

3. Subcontractor shall notify the Fermilab Construction Coordinator in advance of any work on the AC Electrical Distribution System where the system is energized or is capable of being energized. The Fermilab Construction Coordinator shall review the scope of work and, if warranted, obtain required notifications, permits and authorizations for the work activity.

F. All 3-phase power distribution shall conform to the positive phase rotation convention. Positive phase rotation shall be understood as Phase A, Phase B, Phase C, where Phase B lags Phase A and Phase C lags Phase B. Subcontractor shall verify proper phasing of all electrical systems.

The voltage phasor diagram and time-based voltage waveforms of the 3-phase power distribution system are illustrated below:



Three Phase Phasor Diagram and Time-Based Waveforms

3.05 SPECIAL SYSTEMS AND MISCELLANEOUS

A. Nameplates and Tagging: Subcontractor shall furnish and install lamocoid nameplates for all electrical equipment. Nameplates shall be affixed with 3M 9500PC, double-side, adhesive tape for indoor locations and self-tapping stainless steel screws for outdoor locations. See individual equipment sections for nameplate requirements.

B. Painting: Subcontractor shall do all touch-up painting on electrical equipment that may have been damaged during installation. Subcontractor will not be required to do touch-up painting on motors. Touch-up paint for all equipment shall be supplied by the Subcontractor.

C. Calibration: Calibration and setting of protective devices, relays, and breakers (including motor control center protective devices) shall be performed by qualified technicians supplied by the Subcontractor in accordance with manufacturer's instructions.

3.05 PROTECTION OF INSTALLED EQUIPMENT: During the construction period and until the work has been accepted by the Fermilab Construction Coordinator, Subcontractor shall protect all raceways and other equipment from the adverse effects of water, dampness, dust, falling objects and injury due to the activities of Subcontractor's workmen and others (including other subcontractors). In the event that damage occurs to equipment due to the work or negligence of the Subcontractor (as solely determined by the Fermilab Construction Coordinator), Subcontractor shall replace, repair, or have repaired the damaged item or equipment. The replaced or repaired items or equipment shall be subject to the acceptance of the Fermilab Construction Coordinator.

END OF SECTION 16010

SECTION 16015 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes the general Electrical Requirements for Mechanical Equipment, for equipment or material furnished by the respective Subcontractor, where the manufacturer shall furnish all material, equipment, and devices to construct, install and test the complete electrical system and related work for mechanical equipment systems.

B. Respective Subcontractor shall be ultimately responsible for meeting the criteria of this Section.

C. Requirements described in the specific equipment sections take precedence over those requirements described herein.

1.02 APPLICABLE STANDARDS

The organizations listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as modified by the requirements specified herein or the details on the drawings, work included in this section shall conform to the applicable provisions of these organizations:

A. ANSI (American National Standards Institute)

B. ASTM (American Society for Testing Material)

C. FM (Factory Mutual)

D. ICEA (Insulated Cable Engineers Association)

E. IEEE (Institute of Electrical and Electronic Engineers)

F. NEMA (National Electrical Manufacturers Association)

G. NFPA (National Fire Protection Association)

1. NFPA 70 (National Electric Code)

H. OSHA (Occupational Safety and Health Administration)

1. Including all applicable amendments.

I. UL (Underwriters' Laboratories, Inc.)

J. When resolving conflicts the following order of precedence shall apply:

1. Subcontract Sections

2. Subcontract drawings
3. Reference standards

1.03 SUBMITTALS

A. Subcontractor shall provide information and data per the specific equipment sections.

B. Subcontractor shall provide a written statement of compliance with applicable Sections or a specific list of exceptions, referring to each Section and paragraph number.

C. Submittal Requirements. As a minimum, drawings, documentation and instruction manuals shall include:
1. Dimensional outline drawings, showing location of all major electrical equipment including junction boxes, panelboards and motors. Location and size of external conduit connections to the boxes shall be shown.
2. Electrical single Line diagram(s).
3. Electrical schematic diagram(s).
4. Electrical wiring diagram(s).
5. Software.
6. Detailed bill of material, including name of manufacturer and catalog number of all components.
7. Recommended spare parts list with pricing.
8. Installation and operation instructions.
9. Trouble shooting instructions.
10. Review of any drawings or documentation by the Fermilab Construction Coordinator does not release Subcontractor from any Section requirements, obligations or commitments.

1.04 PREPARATION FOR SHIPMENT

A. Equipment or material shall be consolidated into as few packages or sections and shipments as practical, consistent with transportation restrictions.

B. The following information shall be supplied with the shipment of the equipment:
1. The contents and bill of lading, including number of shipments.
2. Method of shipment.
3. Date of shipment.
4. The shipment shall have protection to prevent damage by high humidity, water, ice, snow, dust, or other potentially damaging conditions. Components shall be adequately braced and protected to prevent damage during shipment.

C. Components of the equipment and material shall be clean and free of rust, loose scale, grease or other foreign material.

D. A book of special instructions for unloading, unpacking, handling and storage of the equipment or material shall be labeled “Special Instructions” and stored in a weatherproof enclosure.

E. Each shipping entity (such as box or crate) shall be tagged on the outside with the purchase order number, purchase order item name and equipment number in 2-1/2 in. block letters. Tagging shall be mounted in a fully visible location.

F. Individual pieces of equipment or material shall have securely attached a non-corroding metal tag bearing the equipment number, purchase order number, date of manufacture, vendor’s name and model number.

G. Rail shipments shall require the use of an accelerometer device for determining excessive impact during rail transit. The accelerometer shall be a chart recorder type.

H. Preparation for shipment shall be in accordance with Manufacturer’s standards, unless noted otherwise. Subcontractor shall be solely responsible for the adequacy of the preparation for shipment provisions employed in respect to materials and application and to provide materials to their destination without damage when handled by commercial carrier systems. Subcontractor shall be fully responsible for the equipment until the Subcontract package is accepted by Fermilab.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with the requirements of Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and sections shall be required.

C. Subcontractor shall call to the attention of the Fermilab Construction Coordinator any discrepancy found in the sections. No deviations from the sections shall be made without prior written authorization from the Fermilab Construction Coordinator.

D. Manufacturer shall have a Quality Control System that collects and records similar equipment’s field operating abnormalities and failures due to the design, materials, processes, and workmanship. If, after the Manufacturer furnishes the specified equipment, abnormalities and failures are experienced in field applications of similar equipment, it shall be the Manufacturer’s responsibility to advise Fermilab if such abnormalities and failures present a significant hazard.

PART 2 - PRODUCTS

2.01 All components and equipment shall be new, shall be of the latest design and shall be standard products of a manufacturer regularly engaged in the production of such equipment.

2.02 Equipment shall be designed for ease of field erection and field maintenance. It shall be warranted to perform to these Sections with a minimum of field maintenance. Equipment shall be void of safety hazards to authorized operating personnel and the general public.

2.03 When specified or requested by Fermilab, Subcontractor shall supply a certificate of conformance that the equipment furnished complies with the applicable standards of ANSI, IEEE, and NEMA, and with these Sections. This request may be made at any time by the Fermilab Construction Coordinator. Manufacturer 's certificate shall also indicate that quality-control records are on file.

2.04 Tests and checks shall be made by the Manufacturer prior to shipment that all electrical equipment and wiring is in proper operating condition and that the wiring is in exact accordance with the Manufacturer's "as built" wiring diagrams. All test procedures and test results shall be submitted for review.

2.05 Any expenses incurred by Fermilab necessary to bring the schematics, wiring diagrams or actual wiring into conformance with each other and these sections may be backcharged to the Subcontractor.

2.06 Where equipment has failed to pass any test, the Fermilab Construction Coordinator shall be notified in writing as to the nature of the failure and the corrective measures applied.

2.07 Control Equipment: Components mounted on or within panels shall be so spaced and the wiring connections to them so arranged, that they shall not interfere with maintenance and testing of any equipment. Components requiring occasional service shall be accessible without removal from the cabinet or disconnection of field wiring. When located behind the panels, the components shall have identification labels on the outside of the panels to allow easy location.

2.08 ENCLOSURES

A. All indoor enclosures shall be rated NEMA 1, unless noted otherwise.

B. Generally, outdoor enclosures shall be rated NEMA 3R. All outdoor enclosures shall be provided with drains for removal of condensation.

C. All steel surfaces shall be properly prepared for painting and suitably primed. Generally, the exterior finish coat shall be ANSI No. 61 light gray. Painting is not required for stainless steel enclosures.

D. All non-current carrying parts of electrical equipment shall be bonded together and made electrically continuous. Two (2) ground pads shall be

furnished at the edge of the skid. Grounding lugs shall be provided inside the terminal boxes to terminate the ground conductor.

E. Electrical equipment enclosures shall allow for both top and bottom entry of all power, control and instrument cables.

F. Panels shall be provided with either a fused disconnect switch or circuit breaker to disconnect all incoming supply voltages, unless noted otherwise.

2.09 CONDUIT SYSTEM

A. All wiring shall be installed in hot-dipped galvanized rigid steel conduit for exposed outdoor locations and intermediate metal conduit for indoor locations. Minimum conduit size shall be 3/4 in.

B. Flexible conduit connections shall be used to avoid transmission of vibration from vibrating equipment to the conduit system. It shall also be used to terminate periodically removable connections such as to motors, instruments, and thermocouples. Maximum length of flexible conduit shall be 36 in.

C. Exposed conduit shall be run vertically, horizontally or parallel to the structure line. Conduit bodies and junction boxes shall be accessible and shall be supported independent of the conduit system. Whenever practical, horizontal conduits shall be sloped for drainage. Conduit shall not be installed behind the ladder rungs or at platform levels in such a manner as may cause false and insecure step. Drain breathers shall be installed at low point of vertical conduit runs.

D. Conduit connections to junction box shall be made using insulated, watertight threaded hubs or factory-threaded hubs.

E. Unless noted otherwise, one (1) feeder shall be furnished to furnish power to all loads on the unit. A single feeder shall be provided to a single transformation and distribution of this power on the unit and for providing DC power supplied, if required.

2.10 WIRING

A. All conductors, except thermocouple extension wires, shall be single conductor, stranded copper, Type THWN/THHN.

B. Wiring for 480 VAC services shall be not smaller than #12 AWG.

C. Control wiring (120 VAC) shall be a minimum of #14 AWG coated stranded copper. Extra flexible stranding shall be used for interconnections between hinged doors with instruments and stationary terminal blocks located within panels.

D. Electronic component wiring shall be in accordance with Manufacturer's standards, using wire sizes no smaller than #18 AWG stranded for external wiring. Wiring shall be twisted shielded pair or triad.

E. Wires shall be tagged at both ends with sleeve type wire tags according to the electrical connection drawings.

F. Voltage levels, grounded conductors, equipment grounding conductors, and ungrounded phase conductors shall be identified by the following color coding system:

1. 120/208 VAC 3-Phase Systems:
   a. Grounded neutral: White.
   b. Grounding Conductor: Green or bare.
   c. ØA (ungrounded) conductor: Black.
   d. ØB (ungrounded) conductor: Red.
   e. ØC (ungrounded) conductor: Blue.

2. 277/480 VAC 3-Phase Systems:
   a. Grounded neutral: Gray.
   b. Grounding Conductor: Green or bare.
   c. ØA (ungrounded) conductor: Brown.
   d. ØB (ungrounded) conductor: Orange.
   e. ØC (ungrounded) conductor: Yellow.

G. All wiring shall be continuous without splices from terminal to terminal.

2.11 UNLESS OTHERWISE SPECIFIED, ALL AC MOTORS SUPPLIED AS PART OF THE SYSTEM REQUIREMENTS SHALL BE RATED AS FOLLOWS

A. Motor horsepower ratings shall be sufficient to meet the maximum system design load and shall be based on a NEMA Class F temperature rise. This rating shall be based on a 40°C ambient temperature or the actual ambient temperature, whichever is greater. The motor insulation system shall be NEMA Class F, as a minimum.

B. Motors shall be NEMA Design B, squirrel cage induction type, and when operated at rated voltage shall develop a breakdown torque of not less than 190 percent of normal running torque. If the driven equipment requires a higher torque, the proper NEMA design shall be furnished.

C. Outdoor or wet location motors shall be Totally Enclosed Fan-Cooled (TEFC). Indoor motors shall be drip-proof. Motors rated above 100 hp shall have 120 VAC, 60 Hz space heaters, unless noted otherwise.

D. Motor windings shall be copper.

E. Motors shall be suitable for across the line starting.

F. Motors rated 1/2 hp and less shall be rated 115 VAC, 1Ø, 60 hz, for operation on a 120 VAC system.

G. Motors rated above 1/2 hp to 200 hp, inclusive, shall be rated 460 VAC, 3Ø, 60 Hz, for operation on a 480 VAC system.

H. Generally, motor service factor shall be 1.15.

I. Fractional horsepower motors shall be of the sealed pre-lubricated ball bearing type. Larger sized motors shall have ball bearings with pressure grease fittings and drains, unless noted otherwise.

J. The following listed minimum acceptable motor efficiencies for single speed polyphase motors:

Horsepower	Minimum % Efficiency
1-4	84.0%
5-9	88.0%
10-19	89.0%
20-49	93.0%
50-99	93.0%
100-124	94.0%
125 and above	95.0%

K. Single speed motors shall have single windings and two (2) speed motors shall have two (2) windings.

L. All motor wiring branch circuits shall carry a green ground conductor to the motor terminal box.

M. If equipment design provides for field adjustments and/or changes that will increase the power required (e.g., changes in exhauster or fan blade length), drives furnished shall be adequate for the power that may be required by such subsequent adjustments or changes.

2.12 MOTOR CONTROLS

A. Unless noted otherwise, Manufacturer shall furnish all controls, interlocks, wiring, etc., for the complete operation and protection of the unit.

B. Motor starters shall be full-voltage, non-reversing combination type with motor circuit protector (MCP), unless noted otherwise.

C. Unless specified otherwise, individual AC motor starters or contactors shall be furnished with the equipment. Units shall be in accordance with the following:
   1. Motor starters shall be combination circuit-breaker type (MCP).
   2. Motor circuit protector shall be rated 600 VAC with adjustable magnetic trip and a minimum interrupting rating of 35,000A (sym), minimum.
   3. Motor starter shall be Cutler Hammer “Advantage” type rated at 600 VAC with “Poni” card for Fermilab remote monitoring. Advantage Freedom starter line shall NOT be acceptable. Manufacturer shall

furnish all starter protection settings. Protective device settings shall be programmed by the Manufacturer.

4. Any low voltage controller or PLC system for any starter shall be in a separate section/bucket or shall have a barrier between low voltage controller and line voltage. Low voltage controller shall have access for maintenance separate from the line voltage.
5. Starters smaller than NEMA Size 1 shall not be used.
6. Unless noted otherwise, all starters shall be furnished with a 480-120 VAC control power transformer, with 50 percent spare capacity, with one (1) side of the secondary fused and the other side of the secondary grounded.
7. Unless specified otherwise, motor starter controls shall include one (1) red “running” indicating light, one (1) green “off” indicating light, one (1) “Manual-Off-Automatic” control switch or “On-Off” pushbuttons, and two (2) normally open and two (2) normally closed auxiliary contacts. Motor starters shall be capable of being locked in the “Off” position.
8. Motors rated less than 460 VAC shall be furnished with a manual motor starter with an H-O-A selector switch and red (running) indication light.

9. Provide 24V DC start relay to interface with automation / alarm systems as required.

PART 3 - EXECUTION

3.01 THE EQUIPMENT MAY BE INSPECTED By The Fermilab Construction Coordinator, And The Following Tests Shall Be Performed In The Inspector’s Presence

A. All circuits shall be checked for continuity.

B. Wiring at all voltage levels, except for low energy and electronic circuits, shall be checked for insulation resistance.

C. Functional test to ensure proper operation of all devices and components shall be performed.

3.02 A CERTIFIED TEST REPORT Shall Be Submitted To Fermilab

3.03 ALL ELECTRICAL EQUIPMENT AND ENCLOSURES Shall Be Identified With Nameplates. Nameplates Shall Be Manufacturer’s Machine Engraved Lamocoid With White Letters On Black Background And Shall Be Firmly Attached With 3m 9500pc, Double Side, Adhesive Tape For Indoor Locations And Self-Tapping Stainless Screws For Outdoor Locations

A. Each unit of equipment shall have the manufacturer’s identification nameplate indicating a catalog number, description, and serial number.

B. Externally and internally visible, permanent nameplates shall be provided identifying each instrument, switch, meter, relay, control switch, indicating light, etc.

3.04 EACH STEEL STRUCTURE Shall Be Thoroughly Cleaned, Inside And Out, After Fabrication, And Receive A Rust Inhibiting Metal Primer Coat And Final Coat Of Ansi 61 Light Gray Paint, Unless Noted Otherwise

END OF SECTION 16015

SECTION 16060 - GROUNDING AND BONDING

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for grounding and bonding. Subcontractor shall furnish, install, terminate, test and place into operation all grounding and bonding, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 16010 – General Electrical Requirements

B. Section 16080 – Electrical Testing and Inspection

C. Section 16120 – Low Voltage Wire and Cable - 600V

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. IEEE (Institute of Electrical and Electronics Engineers Inc)

1. Standard 142
2. Standard C2 (National Electrical Safety Code)

B. NFPA (National Fire Protection Association)

1. NFPA 70 (National Electrical Code)

C. Underwriters Laboratories, Inc.

1. Publication UL467

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A-Section 12.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with the requirements of Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 Subcontractor shall provide all material, equipment and accessories as required for the complete installation and operation of the grounding system as shown on the drawings.

2.02 Bonding and grounding conductors shall be bare, stranded, uncoated copper.

2.03 Ground rods shall be U.L. listed copper clad steel with 10-mil minimum copper coating, 1" round and 10'-0" long, unless noted otherwise.

2.04 Insulated ground conductors shall be in accordance with Section 16120: Low Voltage Wire & Cable– 600V.

2.05 Ground Bar: 1/4-inch thick solid hard drawn copper. Provide 2-inch stand-off insulators, 3/8-inch bolt size. Provide pre-drilled holes to accommodate 3/8-inch bolts on 1-inch centers.

PART 3 EXECUTION

3.01 Service building grounding system shall consist of grounding electrodes driven in earth with equipment and building steel connected to the electrodes. The grounding plans and details indicate the minimum requirements for the grounding systems. Ground systems shall be in accordance with the applicable IEEE standards and the NEC.

A. Top of ground rod shall not be less than 18-inches below finished grade, unless noted otherwise on the subcontract drawings.

B. Grounding conductors shall not be less than 30-inches below finished grade, unless otherwise noted on the subcontract drawings.

3.02 Grounding conductors extended above-grade and exposed to possible damage shall be suitably protected by installation in conduit, unless noted otherwise.

3.03 Ground buses or conductors shall not be looped between pieces of equipment. Equipment shall be directly connected to ground electrodes, buses or the main grounding bus.

3.04 All sub-grade grounding installations shall be inspected by the Fermilab Construction Coordinator prior to backfill.

3.05 Exothermic (Cadweld) welding process shall be used for the following connections:

A. For grounding cable above and below grade.

B. All ground wire taps.

C. Any non-accessible ground connections: Low emission welding process (smokeless and filtered molds) shall be utilized for ground connections indoors.

3.06 Exothermic welds shall be made using molds specific for each cable size, ground rod size, bar or plate connection and configuration.

3.07 All contact surfaces shall be thoroughly cleaned of dirt or oil. Where bolted connections are used, all surfaces shall be treated with a corrosion-inhibiting compound. All lugged connections in wet locations or outdoors shall be tinplated.

3.08 Ground conductor penetrations through concrete structures (where water seepage can occur through the strands of cables) shall be made through use of a copper bar. Copper bar shall be of equal current carrying capacity as that of the connecting ground conductors. Copper bar shall extend such that connection to the ground cable is readily available.

3.09 Ground cable supported off concrete supports shall be through the use of copper clamps.

3.10 Grounding circuit connections shall be such that grounding resistance may be checked at anytime.

A. Each grounding circuit shall have a resistance of not greater than 0.5 ohms at the building transformer ground point. Sufficient grounding electrodes shall be furnished and installed by the Subcontractor at no additional cost to Fermilab to meet the requirements of this section.

B. If the resistance cannot be met by adding additional ground rods, then a low resistance ground fill, such as Ultrafill (Harger Lightning Protection, Inc., Grayslake, IL) shall be employed around the rods.

3.11 As a minimum, the followings items shall be connected to the grounding system either directly or through bonding:

A. Grounding above and below grade.

1. All structural steel and metal structures shall be connected to the building ground electrode. This shall include, but not be limited to, steel columns, steel beam metal decking and structural metal stairs.
2. Buildings with medium voltage equipment, explosion proof equipment or noise sensitive equipment shall be provided with a bare ground loop conductor and shall be 500 MCM secured to the building structure or direct buried, as noted on the drawings. Ground grid main conductor shall be located proximal to the building footing and shall be installed a minimum of 2’-6” below finished grade, per 2011 NEC Article 250.53.
3. Ground rods shall be installed at 12’-0”, minimum, from the building columns, spaced at intervals indicated on drawings and connected to columns with 500 MCM cable.

4. All connections to building columns shall be exothermic (Cadweld) weld type and shall be made above finished grade wherever possible. Below grade connection shall also use exothermic connections.
5. Exposed ground conductors shall be supported every 4’-0”.

B. Equipment Grounding

1. Non-current carrying metallic parts of electrical equipment and installations, such as panelboards, pushbutton stations, motors, starters, raceway systems and lighting luminaires shall be solidly connected to the grounding system. Bolted connections shall be made to all equipment to insure a permanent ground, in accordance with IEEE standards and the NEC.
2. Stationary equipment isolated from ground steel shall be effectively grounded by use of a copper ground conductor bonding the equipment to the station ground or other permanently grounded structure.
3. The use of raceways or conduit to meet the above requirements is not an acceptable method for grounding of the equipment.

C. System Grounding:

1. All grounding shall conform to Article 250 of the 2011 National Electrical Code.
2. For 277/480 VAC and 120/208 VAC wye grounded systems, the neutral (grounded) wire of the systems shall be connected to the system ground at the transformer (source) and at no other points.

D. All panelboards, disconnect switches, etc., shall be provided with a bare #2 AWG bond wire from the panel board enclosure to the ground system. This is in addition to the ground conductors routed with phase conductors.

3.12 Transformer Grounding

A. Subcontractor responsible for the installation of the transformer shall provide for the grounding of the transformer.

B. A ground loop shall be installed around the perimeter of the transformer pad with connections to the transformer ground lugs in primary and secondary compartment. The grounding shall be as follows:

1. Transformers rated 750kVA and below, ground loop shall be 500 MCM bare copper. Ground tap connections to the transformer shall be #500 MCM bare copper.

C. The ground loop conductor shall be located a minimum 18-inches outside the perimeter of the concrete pad and a minimum 2’-6” below grade level and below the gravel line of the pad.

D. Each transformer shall be grounded at a minimum of two places on the tank and at minimum of one place in the low voltage termination compartment, unless noted otherwise on the subcontract drawings. Subcontractor shall provide for the neutral/ground connection of delta-wye configured transformers.

1. Installation and routing of ground conductors shall not interfere with the installation of the phase conductors.
2. Ground conductors shall not be looped between pieces of equipment. Each ground point shall have a direct connection to the ground system.
3. Ground rods shall be installed at the corners of the ground loop and at intervals indicated on drawings.

END OF SECTION 16060

SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.04 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.05 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.06 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. Thomas & Betts Corporation.
   e. Unistrut; Tyco International, Ltd.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 9 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 16073

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Electrical subcontractor must follow the Fermi National Accelerator Laboratory standards. Refer to Fermilab document “Standard Conventions for the Fermilab Electrical AC Power Distribution System”.

1.02 SUMMARY

A. Section Includes:
1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.03 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.04 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Identification signs and labels must be complied with the Fermilab Standards.

1.05 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate with requirements from Attachment 1.

C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

D. Coordinate installation of identifying devices with location of access panels and doors.

E. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:
1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.02 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.03 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive, vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.04 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.05 UNDERGROUND-LINE WARNING TAPE

A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Material:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbs. (311.3 N), and 4600 psi (31.7 MPa).

2.06 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
3. Refer to other Division 16 Specifications for additional labels and signs.

2.07 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.08 EQUIPMENT IDENTIFICATION LABELS

B. Panelboards and transformers of the distribution system shall be uniquely identified with labels be made from engraved plastic lamocoid material and

generally 1/16 inch thick, 2.5 inches high, and a minimum 9 inches wide. The overall dimensions may be reduced for cases where the equipment cannot accommodate the standard size.

C. These labels generally have two lines of text. The first line would be the panelboard or transformer name (e.g. PHP-MI60A-3, TR-MI60A-3-A). The second line would describe the operating voltages or voltages present (e.g. 480Y/277 VAC, 480-208Y/120 VAC).

D. First line characters are to be 0.85 to 1.0 inch high with a 1/8 inch line width. Second line characters are 0.5 inches high with a 1/16 inch line width. The edges of the label are to be beveled.

E. RED labels with WHITE characters shall be used for equipment operating at 480Y/277 or 480 VAC or higher. A 480 to 208Y/120 VAC transformer would be outfitted with a label having these colors. When such equipment is capable of being powered by a dedicated Emergency or Standby power source, the equipment label shall be ORANGE in color with BLACK characters.

F. BLACK labels with WHITE characters shall be used for equipment operating at 120, 208Y/120, or 240/120 VAC. When such equipment is capable of being powered by a dedicated Emergency or Standby power source, the equipment label shall be YELLOW in color with BLACK characters.

G. Equipment labels shall be attached with a high quality, double-sided adhesive tape. For indoor applications to smooth surfaces use 3M tape 9500PC. For outdoor or rougher surface applications use Normount tape V2830.

2.09 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

J. Painted Identification: Comply with requirements in Division 9 painting Sections for surface preparation and paint application.

3.02 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot (10-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Emergency Power.
   2. Power.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase. Refer to specification 16120-3.16C.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
      b. Colors for 208/120-V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
      c. Colors for 480/277-V Circuits:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
      d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.

E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Controls with external control power connections.

K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard

identification shall be engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Switchboards.
e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
f. Emergency system boxes and enclosures.
g. Enclosed switches.
h. Enclosed circuit breakers.
i. Enclosed controllers.
j. Variable-speed controllers.
k. Push-button stations.
l. Contactors.
m. Remote-controlled switches, dimmer modules, and control devices.
n. Monitoring and control equipment.

END OF SECTION 16075

SECTION 16080 - ELECTRICAL TESTING AND INSPECTION

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the basic minimum requirements for Electrical Inspection & Testing of electrical equipment and systems for the subcontract, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following section includes items of related work. Coordinate work prescribed by this section with work prescribed by Section 16010 – General Electrical Requirements.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. ANSI (American National Standards Institute).

B. IEEE (Institute of Electrical and Electronics Engineers):

1. IEEE 48 Standard Test Procedures and Requirements for High Voltage Alternating Current Cable Terminations
2. IEEE 81 Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth
3. IEEE 141 Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book)

C. NEMA (National Electrical Manufacturers Association).

D. NETA (National Electrical Testing Association).

E. NETA 1.001 Standards For Acceptance Testing of Electrical Distribution Apparatus 375.

1.04 SUBMITTALS: The following documents shall be furnished to Fermilab either when requested by the Fermilab Construction Coordinator or at the conclusion of the Subcontract.

A. Check list quality control form.

B. Test report quality control forms.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for the quality control and construction inspection in accordance with the requirements of Exhibit A and this Section.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings shall be required.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 GENERAL

A. This section provides guidelines for the inspection, testing and checkout of the electrical systems to ensure that the electrical installation is in accordance with the design sections, drawings and manufacturer's instructions.

B. The listings and descriptions of the inspections, tests and checks described herein shall not be considered as complete and all inclusive. Additional normal standard construction (and sometimes repetitive) checks and tests may be necessary throughout the course of the work.

C. Inspection and test work shall be coordinated with the Fermilab Construction Coordinator. Reasonable notice shall be given to Fermilab to allow witnessing for those tests designated to be witnessed.

D. Equipment or circuitry shall not be energized, de-energized or connected to an existing system without prior review and acceptance of the test plan and procedure, which shall be prepared and submitted by the Subcontractor.

E. The checks and tests shall be documented on the attached Quality Control Forms. Quality Control Forms shall be available for Fermilab review at any time during the subcontract. Completed Quality Control Forms shall be given to the Fermilab Construction Coordinator at the conclusion of the subcontract.

F. Subcontractor shall be responsible for all inspection and test activities. The detail implementation plan shall be reviewed and accepted by the Fermilab Construction Coordinator.

3.02 INSPECTION AND TESTING OF EQUIPMENT AND CABLE:

A. Preparation:

1. A detailed plan and schedule shall be prepared for inspection and testing activities.
2. The testing and checkout of electrical equipment such as transformers, drive equipment, and motor controllers may require notification of the proposed checks to the equipment manufacturer's representative:
   a. Equipment warranties or guarantees shall not be voided by testing and checkout work.

b. Checks and tests shall normally be supplemental to and compatible with the manufacturers' installation instruction leaflets and literature.
c. Where deviations are apparent, manufacturer's review shall be obtained prior to testing.
d. Reasonable cooperation shall be extended to permit witnessing by the manufacturer's representative, if so requested.
e. Where any questionable repairs, modifications, significant adjustments, tests, or checks are to be made, the test supervisor shall contact the Fermilab Construction Coordinator to determine if the work should be performed by or in the presence of the manufacturer's representative.
f. Manufacturer, make, model and serial numbers of the instruments used shall be recorded on the test forms.

3. Testing and checkout work shall be performed with fully qualified personnel skilled in the particular tests being conducted. This is essential for obtaining and properly evaluating data while the tests are in progress and for ensuring relevant facts and questionable data are reported.
4. The test supervisor shall ensure that testing and checkout work is conducted in a safe manner. Special safety precautions such as the following shall be utilized:
   a. Lockout and tag-out procedures.
   b. Barricades.
   c. De-energizing or isolation of equipment prior to testing.
   d. Review of procedures with safety personnel.
   e. Erection of warning signs.
   f. Stationing of guards and watchmen.
   g. Maintenance of voice communications.
   h. Personnel orientation.
5. The test apparatus shall be of the proper voltage class and rating for the test being performed. Care shall be taken that the installation shall not be overstressed.
6. Initial resistance and low voltage tests of the equipment shall be made with the equipment de-energized and with all electrical connections to the devices disconnected and locked out.
7. If resistance measurements on the devices meet the requirements, testing may proceed. Any short or ground shall be repaired, replaced, dried out or otherwise corrected before the circuit is energized.
8. Equipment purchased by the Subcontractor or by Others shall be inspected and tested. Refer to other applicable paragraphs of the Sections for required checks and responsibilities.
9. At any stage of construction and/or when electrical equipment or systems are determined to be damaged, faulty or requiring repairs, the electrical equipment or systems shall be reported to the Fermilab Construction Coordinator. Corrective action may require prior approval.

3.03 GROUNDING SYSTEMS

A. Test building loops and major equipment grounds to remote earth or directly referenced to an extremely low resistance (approximately 1 ohm) reference

ground benchmark. Visually inspect systems, raceway and equipment grounds to determine the adequacy and integrity of the grounding.

B. Test the ground grids for ground resistance to verify a maximum ground resistance:

1. The fall of potential method using the two (2) auxiliary electrodes, or other suitable approved method, shall be used to determine ground resistance values. Refer to Attachment 2, Ground Test Methods.
2. Testing shall be performed as described IEEE Standard 81, IEEE Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.

3.06 MOTOR CONTROLLERS

A. Before making any tests, visually inspect the controllers externally and internally for damage or possible trouble. Wipe the center clean of all construction dirt and dust.

B. Confirm that the starter overload heaters are sized in accordance with the manufacturer's instructions for the motor nameplate full load current.

C. Before motors are run for startup, megger motor cables with a 500-Volt megger with the motor connected. Jog motor to determine correct rotation. After rotating is confirmed correct, set the motor circuit protector breakers in accordance with the manufacturer's recommended procedure, or verify proper fuse ratings in fusible disconnect switches.

D. With motor overloads removed, confirm proper operation of the motor control circuit including start and stop permissive, interlocks, and trip functions.

3.07 LOW VOLTAGE MOTOR

A. At the time of motor receipt, visually inspect each motor for any physical damage.

B. Check motors for proper lubrication.

C. Test the insulation of low voltage motors with a 500-Volt megger and record readings. If a reading is found to be below 1 MegOhm per one thousand (1,000) volts, the motor must be dried until a constant value above the minimum reading is reached.

3.08 SERVICE TRANSFORMERS

A. After primary cable connections are complete, perform an insulation test by means of a 1000-Volt DC megger on all 480-Volt primary, dry type transformers. Megger the feeder cable with the primary winding; the feeder overload protective device shall be open. Secondary leads may be meggered with the secondary windings; the load disconnect device shall be open.

B. Check continuity and correctness of windings connections. The following test values shall be used:

Transformer Winding	Megger Test Reading	Minimum MegOhms
480 Volt Primary	1000	45
208/120 Volt Secondary	500	30

1. Hold megger test voltages for 1 minute.

3.09 600-VOLT WIRE AND CABLE

A. Before energizing, measure the continuity and insulation resistance of every circuit external to equipment with a megger from each wire to all others, and ground. Megger test voltage shall be 1,000-Volt DC.

B. Take insulation resistance measurements of the following:

1. Motor Feeders: With motors disconnected, measure insulation resistance of motor feeders from load side of contactors or circuit breakers. Repeat this test after motors are connected and just before energizing at perhaps lower voltage as limited by the maximum test voltage for the motor.
2. Lighting Panel Feeders: Measure insulation resistance of lighting panel feeders with circuit breakers, lighting transformers, and panel boards connected, but with lighting branch circuit breakers or switches open.
3. Feeder Circuits: Measure insulation resistance of feeder circuits with connections to circuit breakers made up, but with breakers open and load not connected.
4. Lighting Branch Circuits: Measure insulation resistance after lamp holders, receptacles, fixtures, and other similar items are connected but before lamping.
5. Motor Control Circuits (600-Volt): With pushbuttons and over current devices connected, measure insulation resistance from phase to ground only. It may be necessary to lift the neutral ground on the control transformers to perform this test. Isolate any control elements that should not be meggered.
6. Check Cables and Wires for proper identification numbering or color-coding.

3.23 INSPECTION AND TEST OF ELECTRICAL INSTALLATION

A. Subcontractor shall carefully review installation Specifications issued for the project. They shall be familiar with applicable codes/standards and shall have copies available at the work locations for reference. Certain requirements may be defined in the specifications, but not called out on drawings, such as expansion joints in conduits, breathers and drains and support for cable in vertical conduit runs.

B. Additional inspections may be carried out by Fermilab. Fermilab inspection shall not alleviate the requirement for inspection as defined herein.

C. Buried Grounding System:

1. Inspect the in progress installation of the ground/earthing system. This activity shall include the following:
   a. Ground rods for correct type and depth.
   b. Ground conductors and connections, as each portion of the system is installed, prior to backfilling.
   c. Verify that system is being installed in accordance with drawings. Ascertain that a record set of drawings reflecting as built marks is being maintained.
   d. Color code Underground Drawings as required to track in progress installation. Document the inspection of the completed system for each Area, Grounding System Inspection Record. Refer to Attachment 11.
   e. Test the resistance to earth for each ground rod, or designated group of rods, or each foundation, as required by the drawings and specifications. Document the test data on Attachment 12, Grounding Resistance Readings Test Record.
2. Inspect in progress ductbank installation using Attachment 7, Inspection Check List, as a guide. Ensure that a record set of drawings reflecting as built marks is being maintained.

D. Above Grade Grounding and Bonding:

1. Inspect the in progress installation of electrical conduit and cable trays, using Attachment 8, Inspection Checklist, as a guide. This activity shall also include the welding for electrical supports. Establish a subcontract qualification procedure for electrical welders to ensure sound welds.
2. Inspect lighting panel boards and lighting installation in accordance with Attachment 15.
3. Inspect and test bonding to ground for equipment and structures in accordance with Attachment 13 and Attachment 14.
4. Inspect the in progress installation of all cable in accordance with Attachment 9.

Checklist Control Forms Index.

Attachment 1:	Grounding Table
Attachment 2:	Ground Test Methods
Attachment 3:	Insulation Test Methods of Equipment and Cable
Attachment 4:	Maximum Test Voltages
Attachment 5	Quality Control Forms Index

ATTACHMENT 1 - GROUNDING TABLE

Description of Ground	Resistance to Remote Earth in Ohms		Approved Test Methods Reference Attachment
	Desired Value	Max. Accepted Value	
13.8/.480 kV Transformer Grounds	1	2	A or C
Distribution Transformer Grounds	1	2	A, B or C
Building Loops or Steel Stacks, Chimneys, Tanks	2	5	A or C
Towers	2	25	A, B, or C
Gang Operated Switch Handles	2	5	A, B, or C
13.8 kV Switchgear Ground Bus	1	2	A or C
480-Volt Switchgear Ground Bus	1	5	A or C
Distributed Control System - Connected to the Plant Ground Grid	2	5	A or C

ATTACHMENT 2 - GROUND TEST METHODS

Ground Test Methods
Ground test methods A, B, or C as specified in **Paragraph 3.12,** Grounding Systems, are briefly described below:

Test Method A:
Test Method A is basically a true resistance test to remote earth. The current reference rod C2 is driven approximately 2 ft-0 in. deep and 1,000 ft-0 in. from the ground under test. The direction chosen should be such as to facilitate the location of the potential reference rod P2 in line with the C2 rod. A minimum of at least ten (10) readings shall be taken with the P2 rod driven approximately 2 ft-0 in. deep in line, preferably at distances of 100 ft-0 in., 300 ft-0 in., 400 ft-0 in., 450 ft-0 in., 500 ft-0 in., 550 ft-0 in., 600 ft-0 in., 650 ft-0 in., 700 ft-0 in., and 900 ft-0 in. from the ground under test. Plot a curve as the readings are taken of ground resistance in ohms versus distance of the P2 rod in feet. The value of resistance in the flat area of the curve at which the slope reverses direction (positive slope changes to negative slope) is the True Resistance of the ground under test. This method of test is normally used on the more important facility grounds such as main generator and substation system neutral and equipment grounds, and to establish one or more reference ground benchmarks at the site.

Test Method B
Test Method B is a 2-point short version of Method A and is usually quite satisfactory for isolated electrodes or ground electrodes that are less than 30 ft x 30 ft, usually of shallow depth. This type test is usually adequate and convenient for use in testing overhead line and related equipment grounds. The current reference rod C2 is driven 300 ft-0 in. from the ground under test. The P2 potential rod is driven 100 ft from the ground under-test in line with the C2 rod. Ground resistance readings are taken with the P2 rod moved 20 ft-0 in. closer to the C2 rod, readings should be taken and recorded. For a correctly performed test, the resistance readings at 160 ft, 180 ft, and 200 ft should be within 5 percent of each other.

Test Method C
Test Method C may be termed the Direct Reference method whereby the test instrument is used as a direct reading ohmmeter. One set of leads (P1 and C1) is connected to ground under test and the other set of leads (P2 and C2) is connected to a reference ground benchmark that has previously been tested to remote earth by Method A, used most frequently, or Method B. It is important that the reference ground used has very low resistance to remote earth, usually less than 2 ohms is preferred. The test result obtained is the sum of the ground under test to earth and that of the reference benchmark to earth as a maximum reading. If the reference benchmark by previous test to remote earth is negligible, then the reading obtained may be taken as that of the ground under test. Otherwise, the readings should be subtracted and the result would be considered as a maximum resistance to remote earth of the ground under test.

ATTACHMENT 3 - INSULATION TEST METHODS OF EQUIPMENT AND CABLE

General
Subcontractor shall perform, or have performed by the independent testing firm, DC insulation tests of the type specified on electrical equipment, apparatus, and cables under any one (1) or more of the conditions described below at the time equipment such as motors, transformers, and similar electrical equipment is:

Delivered or turned over to Subcontractor for care, storage or installation. Before energization or placing into service and acceptance by Fermilab. When damage to the insulation is suspected or known to exist. After repairs or modifications to the equipment affecting the installation. Routinely as necessary to determine or evaluate the condition of the insulation, especially moisture conditions, to determine the need for drying, cleaning or other maintenance work or protection. Where lightning or other surge conditions are known to have existed on the circuit.

Insulation tests are required by Supplier or the independent testing firm at various stages of construction. The equipment, cable and systems that require testing, the maximum test voltages, and the type test required are specified under the specific equipment type.

Test Methods
Three types of insulation tests are referred to or required by this specification. They are briefly described below. At the conclusion DC tests, grounds shall be applied to the cable or equipment windings for at least twice as long as the duration of the applied voltage. This is needed to discharge the capacitive voltage built up during the test.

Proof Test
Involves the application of a DC voltage in excess of the equipment rating. The test voltage is held constant for a specified time and the behavior of the insulation current, voltage, and resistance are observed for changes that may indicate approaching failure or poor insulation conditions. The magnitude of the insulation resistance is also considered in the evaluation of the insulation. This test may be conducted with a constant voltage megger or variable voltage source as appropriate.

Step Voltage Test
In this test, the voltage is applied to the insulation in consecutive steps of specified magnitude to a maximum value in excess of the equipment rating. The voltage is held constant at each step for a selected period of time, usually 1 minute. At the end of each period, the insulation resistance is determined by the measurement of the current and voltage. A curve of resistance versus voltage is plotted as the data is obtained. At the final test voltage step, the voltage is usually held constant for an additional period of time, usually 3 minutes, and readings taken at one (1) minute intervals. The behavior of the meters is closely observed during the entire test. The test is stopped at any voltage step if results show questionable insulation.

Megger or Insulation Resistance Test
A simple, short test where DC voltage of 100 to 2,500-Volts is applied to a cable or winding from a constant source of potential, such as a James G. Biddle Co. megger insulation tester. The voltage is usually considerably below the maximum test value permitted. The insulation resistance is read directly off the indicator and is in megohms. The quality of the insulation is evaluated based on the level of insulation resistance. This test is usually the routine test conducted by Supplier or may be a preliminary test to a more important proof or step voltage test.

ATTACHMENT 4 -MAXIMUM TEST VOLTAGES

Maximum Test Voltages

1. Maximum Test Voltages for DC Over potential Tests of Equipment

The maximum test voltages for DC insulation tests on windings of rotating machines and transformers are generally determined by Formula 1 and 2 below and are shown in Table 1 for the nominal voltages. They shall not be exceeded except by specific authorization of Supplier's Representative.

a. Formula 1:
(For AC Equipment) Vmax = (2Vrac + 1,000) 1.7* x 0.60**

b. Formula 2:
(For DC Equipment)***Vmax = (2Vrdc + 1,000) x 0.60**

Vmax = The maximum DC test voltage and the recommended test voltage (unless otherwise specified).

Vrac = The rated AC voltage (RMS phase-to-phase) of the winding under test.

Vrdc = The rated DC voltage of the winding under test.

* The factor of 1.7 is the generally accepted value for converting test voltages from DC to AC and is based on extensive test results. The DC to AC ratio of 1.7 is used for equivalence in searching for weakness.

** The 0.60 value is a derating factor for equipment, which is in service. However, unless specific authorization is given, this factor shall be used to determine the maximum DC test voltage for all equipment - new, used, or repaired.

*** The field windings (rotor) of synchronous generators shall not be tested at voltages greater than 500-Volts DC.

2. Maximum DC high potential Test Voltages for Alternating Current Rotating Machines, Transformers, and Cables. (Refer to Table 1 for maximum test voltages.)

A. Miscellaneous Equipment

Circuit breakers, switchgear bus, insulators, disconnects, bushings, potheads, tap boxes, switches, and similar equipment types should normally be tested at three (3) times the alternating current rms rated voltage. These test values are considered to be realistic in most cases for testing this type of equipment. Other cases where it is desired to test at voltages exceeding three (3) times the rating or at values greater than 80 percent of the factory test shall be considered individually and approved by Supplier's Representative before proceeding with the test.

B. Maximum DC Test Voltages for Isolated Cables Rated Over 600-Volts

The maximum DC test voltage for medium voltage (over 600-Volts) wires and cables shall normally be as specified by the following ICEA-NEMA standards:

- ICEA-NEMA DC Test Voltages After Installation Tables: particular cable type.
- ICEA s-66-524 (NEMA WC-7): XLPE insulation.
- ICEA S68-516 (NEMA WC-8): EPR insulation.
- ICEA S67-401: armored cable.

The maximum DC potential applied for field acceptance must never exceed 80 percent of the final factory applied DC test voltage.

Nominal Operating Voltages	Maximum DC Test Voltage And Recommended Voltage (Tests at Lower Voltages May Be Required)
0-100 V AC	500-Volt DC
100-130 V AC	1,300-Volt DC
208-240 V AC	1,500-Volt DC
440-480 V AC	2,000-Volt DC
2,400 V AC	6,000-Volt DC
4,160 V AC	10,000-Volt DC
7,620 V AC	17,000-Volt DC
13,800 V AC	30,000-Volt DC
120 V DC	800-Volt DC
250V DC	1,000-Volt DC

ATTACHMENT 5 -QUALITY CONTROL FORMS INDEX

Attachments referenced in this section,
but not listed below are not applicable to this Subcontract.

Attachment 6	Form 65F1300	Electrical Punch List Record
Attachment 7	Form 65F1200	Underground Conduit (Duct Bank) Inspection Record
Attachment 8	Form 65F1202	Aboveground Conduit Inspection Record
Attachment 9	Form 65F1204	Cable Pulling Inspection Record
Attachment 10	Form 65F1101	Insulation Resistance Test Record
Attachment 11	Form 65F1105	Ground System (Grid or Loop Type System) Inspection Record
Attachment 12	Form 65F1106	Grounding System (Anode Testing) Test Record
Attachment 13	Form 65F1108	Ground Continuity (Non-Electrical Equipment/Structures) Test Record
Attachment 14	Form 65F1109	Ground Continuity (Electrical Equipment and Ground Test Bars) Test Record
Attachment 15	Form 65F1110	Panelboard Inspection Record
Attachment 16	Form 65F1112	Insulation Resistance (Transformer) Test Record
Attachment 17	Form 65F1122	480-Volt Motor Circuit Test Record
Attachment 18	Form 65F1124	Insulation Resistance (Equipment) Test Record
Attachment 19	Form 65F1127	Electric Motor-Electrical Activities Inspection Record
Attachment 20	Form 65F1128	Electric Motor-Mechanical Activities Inspection Record
Attachment 21	Form 65F1129	Electric Motor Run-In Test Record
Attachment 22	Form 65F1130	Insulation Resistance (Rotating Equipment) Test Record

ATTACHMENT 6
FORM: 65F1300
ELECTRICAL PUNCH LIST RECORD

DATE:		REV.:	REF. DWG.:/SPEC:	
Item No.	Identification & Location	Remarks	Date Corrected	Supervisor's Approval

DISTRIBUTION:

SUBCONTRACTOR/DATE_____

ATTACHMENT 7

FORM: 65F1200
UNDERGROUND CONDUIT (DUCT BANK) INSPECTION RECORD

DATE:

REV.:

	NOTE: THIS CHECKLIST SHALL BE USED DURING THE INSPECTION OF UNDERGROUND CONDUIT (DUCTBANK) INSTALLATIONS.	CHECK ITEM
1.	Trenching checked for location, elevation and forming. Check for conflicts with other construction.	
2.	Conduit size, type and location checked for conformance to sections and drawings. Conduit sloped to drain into manholes.	
3.	Rigid steel elbows used for all stub-ups, including PVC runs.	
4.	Conduit seals installed in accordance with drawings.	
5.	Minimum concrete coverage will be in accordance with sections on all sides of conduits.	
6.	Conduit spacing, supports and tie downs correct.	
7.	Stub-up dimensions and location checked.	
8.	Field bent radius correct in accordance with drawings/sections.	
9.	Bends free of deformities.	
10.	Pipe caps on all ends.	
11.	All conduit connections tightly made.	
12.	Reinforcing bars installed when specified.	
13.	All field changes recorded on as-built drawings.	
14.	Trench or forms free of debris.	
15.	Concrete coverage adequate, spacers not left exposed.	
16.	Concrete color in accordance with sections.	
17.	Stub-up concrete encasement correct.	
18.	Backfill and compaction correct.	
19.	Conduits free of such things as stoppages and grout leakage.	

DISTRIBUTION:

SUBCONTRACTOR DATE: _____CAUTION: Target code for cross reference to last page of document follows this comment. Be careful not to delete it.

ATTACHMENT 8
FORM: 65F1202
ABOVEGROUND CONDUIT INSPECTION RECORD

DATE:

REV.:

	NOTE: THIS CHECKLIST SHALL BE USED DURING THE INSPECTION OF CONDUIT.	CHECK ITEM
1.	Supports and spacing in accordance with Sections, codes and drawings	
2.	Supports adjacent to terminal fittings.	
3.	Conduits clean, stub-ups protected, open ends plugged, damaged during construction repaired.	
4.	Field bend radius correct in accordance with Sections and codes.	
5.	Bends free of deformities.	
6.	Expansion joints as required.	
7.	Installation neat and evenly spaced	
8.	Conduit permanently and effectively grounded, unless Sections permit otherwise. Bonding jumpers installed around expansion joints.	
9.	Proper fittings installed with threads fully engaged, no wrench cuts, conduit ends have bushings and covers installed.	
10.	Drains installed in accordance with Sections.	
11.	RGS, PVC or PVC coated conduit installed when specified on drawings.	
12.	Flexible conduit installed with proper bending radius and with standard fittings.	
13.	Junction boxes leveled and supported with proper hubs, locknuts and bushings installed, in accordance with drawings. Junction boxes properly identified.	
14.	Adequate number of pulling points.	

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ATTACHMENT 9
FORM: 65F1204
CABLE PULLING INSPECTION RECORD

DATE:

REV.

	NOTE: THIS INSPECTION CHECKLIST SHALL BE USED FOR CABLE PULLING IN CONDUIT.	CHECK ITEM
1.	Check that underground conduit has been swabbed-out and any standing water removed	
2.	Check that number of pulling points is adequate and the number of bends between pulling points does not exceed Section or code requirements.	
3.	Check cable reel assignments and cutting schedules.	
4.	Check cable voltage rating, minimum pulling temperature and type of pulling compound.	
5.	Inspect cables for jacket damage.	
6.	Ambient temperature within manufacturer's recommended installation limits.	
7.	Monitor pulling tension on critical pulls and verify that maximum permitted tension not exceeded in accordance with tension data.	
8.	Bend radius of trained cable is in accordance with Specifications and cable is free of kinks.	
9.	Installation is neat and cable lay (maintained spacing) in accordance with Sections.	
10.	Cables identified in accordance with Sections and drawings.	
11.	Cable ends sealed after cutting.	
12.	Handhole grounding system installed.	
13.	Cable neutral conductors grounded.	
14.	Cables fire wrapped in hand-holes.	

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ATTACHMENT 10
FORM: 65F1101
INSULATION RESISTANCE TEST RECORD

DATE:

REV.:

TEST EQUIPMENT:_____TEST

VOLTAGE:_____

AMBIENT TEMPERATURE:_____ °C _____°F

NOTES:

1. Perform Insulation Resistance Test (megger) between each conductor and all other conductors and metallic sheath for cables with non-shielded conductors. Test between each conductor and shield for multi-conductor cables with shielded conductors. Record lowest reading for each cable.
2. Use 1000-Volt test set for cable rated 300 to 600-Volts, and 2,500-Volt test set for cable rated over 600-Volts.

PANEL NO. FEEDER NO. CIRCUIT NO.	WIRE TAGGING	CABLE RATED VOLTAGE	QUANTITY	SIZE	FROM	TO	INSULATION RESISTANCE Megohms	INITIALS

Cable-Rated Voltage (Ohms)	Test Duration	Resistance for cable only	Cable/wire size or amperage	Resistance (megohms)	When Cable Connected to Equipment

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ATTACHMENT 11
FORM: 65F1105
GROUNDING SYSTEM INSPECTION RECORD
(GRID OR LOOP TYPE SYSTEM)

DATE:

REV.:

Reference Drawings: _____

	NOTE: THIS INSPECTION RECORD SHALL BE USED FOR INSTALLATION AND CHECKING OF MAIN GROUNDING SYSTEM.	CHECK ITEM
1.	Primary conductor is correct size and type in accordance with drawings	
2.	Ground conductor burial depth and routing per drawings and Sections	
3.	Thermal/compression connections checked (no cold joints or burn outs)	
4.	Thermal/compression connection insulation checked	
5.	Ground anode locations and installation per drawings	
6.	Ground anode connections checked	
7.	Location, type, size and insulation color of equipment taps per drawings and protected during construction	
8.	System ground anode resistance-to-earth checked and recorded on Form 65F1106, Ground Anode Testing Test Record	
9.	All field Revisions recorded on as-built drawings	

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ATTACHMENT 12
FORM: 65F1106
GROUNDING SYSTEM (ANODE TESTING) TEST RECORD

DATE:

REV.:

TEST
EQUIPMENT:_____
_____

REFERENCE
DRAWING:_____
_____

NOTES: Record resistance-to-earth for each anode with all other conductors disconnected. Resistance not to exceed: 25 ohms for any single anode and 0.5 ohm for the system. Check continuity from each anode to any test bar or other anode such that the complete ground loop is tested.

ROD NUMBER OR ANODE NUMBER	RESISITANCE TO EARTH (ohms)	AMBIENT TEMP. °C / °F	WEATHER	TAPS	INITIALS/DATE

DISTRIBUTION:

SUBCONTRACTOR/DATE_____

ATTACHMENT 13
FORM: 65F1108
GROUNDING CONTINUITY TEST RECORD
(NON-ELECTRICAL EQUIPMENT/STRUCTURES)

DATE:

REV.:

TEST EQUIPMENT USED:

WEATHER:

NOTES:
1. Vessels, tanks and structural steel bonded to the main grounding system rod or foundation.

2. Measure resistance from ground wiretap (or anchor bolt) to tagged equipment frame or structural steel.

EQUIPMENT TAG OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

SUBCONTRACTOR/DATE_____

ATTACHMENT 14
FORM: 65F1109
GROUND CONTINUITY TEST RECORD
(ELECTRICAL EQUIPMENT AND GROUND TEST BARS)

DATE::

REV.:

TEST EQUIPMENT USED:_____

WEATHER:_____

NOTES:
1. Electrical equipment bonded to the main grounding system or dedicated ground rod.

2. Measure resistance from ground wiretap to tagged equipment bus bars, tagged equipment enclosures, and any other points indicated on the drawings.

EQUIPMENT TAG OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

SUBCONTRACTOR/DATE_____

ATTACHMENT 15
FORM: 65F1110
PANELBOARD INSPECTION RECORD

DATE:

REV.:

BUILDING:

PANELBOARD:

	NOTE: THIS CHECKLIST SHALL BE USED DURING THE INSPECTION OF PANELBOARDS	CHECK ITEM
1.	Receiving Operations/Inspection complete	
2.	Check assembly for any missing parts	
3.	Enclosure approved for area of installation	
4.	Panelboard circuit schedule filled out	
5.	Correct circuit breaker and location	
6.	Neutral and phase conductors correctly color coded	
7.	Grounding installed and connected. Test Record, Form 65F1109, Ground Continuity Test Record (Electrical Equipment and Ground Test Bars), completed	
8.	Check panel load balance	
9.	Check color coding of branch circuit conductors	
10.	Cleanout	
11.	Check mounting and supports	
12.	Fixtures and receptacles are correct type and installed as per drawings	
13.	Fixtures and receptacles on correct circuit	
14.	Nameplate, number of circuits and panelboard location per drawing	
15.	Megger buses including neutral. Record results on Form 65F1124, Insulation Resistance (Equipment) Test Record. Main disconnect and outgoing circuits should be open.	
16.	Final inspection complete. Punch items on Form 65F1300, Electrical Punch List Record, cleared.	

DISTRIBUTION:

SUBCONTRACTOR/DATE_____

ATTACHMENT 16
FORM: 65F1112
INSULATION RESISTANCE (TRANSFORMER) TEST RECORD

DATE:

REV.:

SUBSTATION NO._____TEST EQUIPMENT:_____

NOTES:

1. Use 1,000 volt test set for 600-Volt equipment and below, 2,500-Volt test set for equipment rated 601 – 5,000-Volts, and 5,000-Volt test set for equipment rated over 5,000-Volts.

2. Test voltage to be applied for 1 minute duration, and reading taken.

3. Neutral must be disconnected from ground during test.

4. Record temperature of insulating liquid for liquid-immersed transformers, and surrounding air temperature for dry type transformers.

EQUIPT TAG NO.	RESISTANCE IN MEGOHMS						PRIMARY TO SECONDARY	VOLTAGE RATING (KV)	PRI-SEC OR AIR	LIQUID TEMP °C / °F
	PRIMARY			SECONDARY						
	ØA-G	ØB-G	ØC-G	ØA-G	ØB-G	ØC-G				

VOLTAGE CLASS RESISTANCE (megohms)
DISTRIBUTION:
TESTER'S INITIALS/DATE:_____

ATTACHMENT 17
FORM: 65F1122
480 VOLT MOTOR CIRCUIT TEST RECORD

DATE:

REV.:

EQUIPMENT DESIGNATION:

MOTOR TAG NO.:	VOLTAGE:	F.L.A.:
kW/HP:	RPM:	S.F.:
CIRCUIT BREAKER MFR:	RATING:	SETTING:
STARTER MFR: SIZE:	SIZE:	O/L HTR.
CONDUCTOR SIZE: POWER:	CONTROL:	GROUND:

	NOTE: THIS CHECKLIST SHALL BE USED DURING THE INSPECTION OF 480 VOLT MOTOR CIRCUITS	CHECK ITEM
1.	Check motor starter for cleanliness.	
2.	Check nameplate data and tagging of motor starter components for conformance to approved supplier drawings.	
3.	Check conduits and/or cables for correct tagging.	
4.	Check installation for seals, breathers and drains.	
5.	Check main and auxiliary contacts of breaker and contactors.	
6.	Manually check mechanical operation of breaker, contactor, O/L relay and O/L reset device.	
7.	Check continuity of power and control cables.	
8.	Complete functional operation check of the motor control circuit using the contract drawings and approved supplier drawings. Close and open the starter using all control devices.	
9.	Verify proper operation of motor winding space heater unit (if provided).	

DISTRIBUTION:

SUBCONTRACTOR/DATE:_____

ATTACHMENT 18
FORM: 65F1124
INSULATION RESISTANCE (EQUIPMENT) TEST RECORD

DATE:
REV.:
TEST
EQUIPMENT:_____
SUBSTATION:_____

AMBIENT TEMPERATURE:_____°C _____°F REF.
SPEC.:_____
REFERENCE
DRAWING:_____

NOTES:
1. Use 500-Volt test set for 600-Volt equipment and below, 2,500/5,000-Volt test set for equipment rated over 600-Volts.

2. For equipment with solid state control circuits consult manufacturer's literature for maximum test voltages.

SWITCHGEAR MCC OTHER	INSULATION RESISTANCE (MEGOHMS)						RATED TEST VOLTAGE (KV)	VOLTAGE (KV)	INITIALS
	ØA-G	ØB-G	ØC-G	ØA-ØB	ØB-ØC	ØC-ØA			

Minimum acceptable Project values:
EQUIPMENT VOLTAGE CLASS: RESISTANCE (megohms)

DISTRIBUTION:

SUBCONTRACTOR/DATE:_____

ATTACHMENT 19
FORM: 65F1127CAUTION: Target code for cross reference to last page of document follows this comment. Be careful not to delete it.
ELECTRIC MOTOR - ELECTRICAL ACTIVITIES INSPECTION RECORD

DATE: REV.:

MOTOR TAG NO.:

	NOTE: THIS CHECKLIST SHALL BE USED DURING THE INSPECTION OF ELECTRIC MOTOR RUN IN ELECTRICAL ACTIVIIES	CHECK ITEM
1.	Equipment Protection Program instituted and documented.	
2.	Nameplate data agrees with motor list, plan drawings, and one-line.	
3.	Motor type is suitable for use in area classification.	
4.	Check the power and control cables Insulation Resistance Tested (megger) prior to connection to motor. Check that Form 65F1130, Insulation Resistance (Rotating Equipment) Test Record is on file.	
5.	For induction motors, perform the following motor tests, as required by the Specifications and document on the appropriate forms. For Form 65F1130, Insulation Resistance (Rotating Equipment) Test Record (megger) synchronous motors test in accordance with manufacturer's instructions	
6.	Grounding conductors installed, connected, and bonded resistance checked from motor frame to ground system tap. Record resistance on Form 65F1109, Ground Continuity Test Record (Electrical Equipment and Ground Test Bars)	
7.	Motor splices and terminations complete. Spare wires (pigtails) on multiple voltage motors properly insulated.	
8.	Motor electrical accessories are properly connected and functioning such as space heater, thermocouples, and vibration switches.	
9.	Cable gland properly made up.	
10.	Bonding jumper installed, when required, across flexible conduit.	
11.	Control station nameplate installed.	
12.	Covers are installed, bolts and nuts are tightened.	
13.	Final inspection complete. Items on Form 65F1300, Electrical Punch List Record, cleared.	

DISTRIBUTION:

SUBCONTRACTOR/DATE:_____

ATTACHMENT 20
FORM: 65F1128CAUTION: Target code for cross reference to last page of document follows this comment. Be careful not to delete it.
ELECTRIC MOTOR – MECHANICAL ACTIVITIES INSPECTION RECORD

DATE:

REV.:

MOTOR TAG NO.:

	NOTE: THIS CHECKLIST SHALL BE USED DURING THE INSPECTION OF ELECTRIC MOTOR RUN IN MECHANICAL ACTIVIIES	CHECK ITEM
1.	Receiving / Operating instructions completed documented.	
2.	Equipment Protection Program instituted and documented one-line.	
3.	Anchor bolts checked for location, elevation and orientation prior to setting equipment.	
4.	Equipment set and checked for location, elevation and orientation.	
5.	Preliminary alignment complete and documented.	
6.	Jackscrews removed and anchor bolts tightened.	
7.	Baseplate grouting complete and documented when manufactured grouts are required.	
8.	Final cold alignment set to manufacturer's tolerances.	
9.	Motor electrical activities complete and documented on Form 65F1127, Electric Motor - Electrical Activities Inspection Record.	
10.	Grease or oil checked to assure proper filling.	
11.	Final coatings checked.	
12.	Verify completion of activities on Form 65F1122, 480-V Motor Circuit Test Record, Form 65F1127, Electric Motor - Electrical Activities Inspection Record, prior to bump and run-in, in accordance with Form 65F1129, Electric Motor Run-In Test Record.	
13.	Final inspection complete. Items on Form 65F1300, Electrical Punch List Record, cleared.	

DISTRIBUTION:

SUBCONTRACTOR/DATE:_____

ATTACHMENT 21
FORM: 65F1129
ELECTRIC MOTOR RUN-IN TEST RECORD

DATE: REV.:

MOTOR TAG NO.:_____ TEST

EQUIPMENT:_____

REF. DWG.:_____
NOTES:
1. Duration of tests to comply with Subcontract Sections.
2. Complete Form 65F1127, Electric Motor - Electrical Activities Inspection Record, prior to energizing motor.

TEST	REMARKS	INITIALS/DATE
RESISTANCE: Bonding resistance measured from motor frame to main ground/earth system tap _____ohms		
VOLTAGE: Actual voltage measured at Motor Controller _____volts		
ROTATION CHECK: Bump motor to verify rotation. Motor shall be uncoupled.		
NO LOAD CURRENT: At beginning of test:_____amps At end of test:_____amps		
TEMPERATURE OF BEARING: Check bearing for high temperature:		

Before start:_____ 15 minutes after start:_____ 30 minutes after start:_____ 1 hour after start:_____ 2 hours after start:_____ 3 hours after start:_____		
VIBRATION: Make visual inspection during run-test. Record any unusual vibration in remarks column.		
NOISE: Record any unusual noise in remarks column.		

DISTRIBUTION:

SUBCONTRACTOR/DATE:_____

ATTACHMENT 22
FORM: 65F1130
INSULATION RESISTANCE (ROTATING EQUIPMENT) TEST RECORD

DATE:
REV.:
TEST EQUIPMENT:_____ TEST

VOLTAGE:_____

AMBIENT TEMPERATURE:_____°C _____°F EQUIP. TEMP., IF KNOWN:_____°C _____°F

HOW KNOWN:_____

NOTES:

1. Use 500-Volt test set for 600-Volt equipment and below, 2,500/5,000-Volt test set for equipment rated over 600-Volts.

2. Test duration shall be one (1) minute; note if otherwise:_____

3. Disconnect each phase winding from neutral, wherever practical. If not practical, test may be made on entire winding.

4. Document testing of low voltage and medium voltage equipment on separate sheets.

5. Readings will vary inversely with temperature. When Project specifies use of temperature correction factors, attach 2nd sheet with computed values. Indicate on each sheet ”Measured" or "Temperature Corrected.

EQUIPMENT TAG NUMBER	INSULATION REISTANCE (MEGAOHMS) *						RATED TEST VOLTAGE (KV)	INITIALS
	ØA-G	ØB-G	ØC-G	ØA-ØB	ØB-ØC	ØC-ØA		

Minimum acceptable Project values:

EQUIPMENT VOLTAGE CLASS: RESISTANCE (megohms)

DISTRIBUTION:

SUBCONTRACTOR/DATE:_____

CAUTION: Target code for cross reference to last page of document follows this comment. Be careful not to delete it.

END OF SECTION 16080

SECTION 16100 – DUCTBANK

PART 1 GENERAL

1.01 SCOPE OF WORK: Work of this section includes ductbank, concrete encasement, reinforcing, trenching and backfilling, and handholes. Subcontractor shall furnish, install, terminate, test and place into operation all material, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections.

A. Section 02220 – Excavating for Structures, Utilities and Pavements.

B. Section 02221 – Backfilling and Compacting for Structures, Utilities and Pavements.

C. Section 03300 – Cast-in-Place Concrete.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications.

A. ANSI (American National Standards Institute):

1. Standard C80.1.
2. Standard C80.3.
3. Standard C2 (National Electrical Safety Code).

B. ASTM (American Society for Testing Materials):

1. Standard A615.

C. NEMA (National Electrical Manufacturers Association):

1. Standard RN1.
2. Standard TC-2.
3. Standard TC-3.

D. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).

E. UL: (Underwriters' Laboratories, Inc.):

1. UL 651.
2. UL 6.

F. Federal Specifications WW-C-540c.

G. Federal Specifications WW-C-581d.

1.04 DELIVERY, STORAGE AND HANDLING: Reinforcing steel and conduit supports shall be stored on pallets, covered to protect them from weather.

1.05 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12.

A. The following submittal documents shall be furnished prior to equipment installation:

1. Conduit (Type and size).
2. Conduit Supports.
3. Hand-holes.

1.06 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 GENERAL

A. All electrical materials shall be new, undamaged and installed for the purpose as manufactured.

B. Substitutions for material as called for on the drawings will be permitted only upon receipt of written approval by the Fermilab Construction Coordinator.

C. All electrical materials shall be UL listed.

D. All conduits shall be encased in 2,000 psi concrete. Red colored dye shall be added to the top of the concrete.

E. Concrete Encased Type EB PVC: Concrete encased Type EB PVC conduit shall be installed for all below grade ductbank. All below grade conduit under paved surfaces receiving vehicular traffic shall be reinforced concrete encased Type EB PVC. All other exterior below grade conduit shall be concrete encased Schedule 40 PVC, unless otherwise noted.

F. Schedule 80 PVC: Shall be installed for all below grade direct bury conduit, as noted on the drawings.

G. Rigid Metal Conduit: Shall be installed for all above grade or for stub up.

2.02 CONDUIT AND DUCT

A. Rigid Plastic Conduit: NEMA TC-2, Schedule 80 rated for use with 90°C conductors under all installation conditions. Carlon Products Co, Robintech, Cantex Inc, Georgia Pipe Co.

B. Rigid Plastic Conduit: NEMA TC-2, Type EB rated for use with 90°C conductors under all installation conditions. Carlon Products Co, Robintech, Cantex Inc, Georgia Pipe Co.

C. Fittings: PVC conduit fittings, NEMA TC-3.

D. Rigid Metal Conduit: ANSI C80.1, Acceptable manufacturers: Allied, Triangle, PWC, Wheatland.

2.03 ACCESSORIES: Fittings and conduit supports shall be suitable for use with conduits and ducts supplied. Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during installation. Underground Devices Inc.

2.04 HANDHOLES: Hand-holes shall be constructed of polymer concrete reinforced with fiberglass, rated for heavy vehicular traffic. Covers shall be of same material as box, colored gray, labeled for ‘Electrical” or “Telecommunications” and secured with stainless steel penta-head bolts. Boxes shall be gasketed water tight construction. Quazite (Strongwell), Associated Plastics, Inc.

PART 3 EXECUTION

3.01 DUCTBANK

A. Excavation for Ductbank:

1. The ground shall be excavated in open trenches to width, depth and in direction necessary for proper installation of underground ductwork and any handholes, etc., and connections as may be shown on plans.
2. Any necessary sheathing to prevent cave-ins, etc. shall be provided by this Subcontractor.
3. Where muck or unstable ground is encountered in bottom of trench, it shall be excavated to a depth of at least 12 in. below line of duct or slab. Where bottom of trench is excavated below necessary elevation, it shall be brought to proper grade by use of torpedo sand or 3/8 in. gravel, well compacted.
4. Where excavation for its entire depth is in water or wet sand, Subcontractor shall install a pumping system connected with well points so as to drain same effectively.
5. Excavations shall be deeper than minimum wherever required in order that ducts or conduits may be installed so as to avoid new or existing piping, etc., as directed by Fermilab Construction Coordinator.

6. Should conduits, ducts, etc. pass under sidewalks, roads, or curbs, Subcontractor shall take up same in order to install conduit or ducts. All sidewalks, roads or curbs shall be replaced with material equal to that removed and shall be as approved by Fermilab Construction Coordinator.
7. SUBCONTRACTOR SHALL PROCEED WITH CAUTION IN EXCAVATION AND PREPARATION OF TRENCH SO THAT EXACT LOCATION OF UNDERGROUND STRUCTURES, UTILITIES AND PIPING, BOTH KNOWN AND UNKNOWN, MAY BE DETERMINED, AND SUBCONTRACTOR SHALL BE HELD RESPONSIBLE FOR REPAIR OF SUCH STRUCTURES, UTILITIES AND PIPING WHEN BROKEN OR OTHERWISE DAMAGED BY SUBCONTRACTOR.

B. Installation of Ductbank:

1. All underground ductbank shall be a minimum of 2 ft - 6 in. below finished grade to top of top duct in bank or as detailed in plans and/or specifications.
2. Extend concrete encasement for ductbank to all handholes, unless otherwise indicated on the drawings, enter and exit all handholes and foundation walls utilizing PVC conduit with end bells.
3. All duct runs shall be separated and supported (before backfilling or pouring concrete) on precast concrete or performed PVC spacers. Minimum space between conduits shall be 2 in. or as detailed on plans.
4. Materials for concrete shall be thoroughly mixed and immediately placed in trench around rigid conduits and ducts. No concrete that has been allowed to partially set shall be used. After duct runs are completed and concrete is set, Subcontractor shall backfill trenches and tamp thoroughly so as to settle the fill.
5. Before Subcontractor pulls any cables into ducts he shall have a mandrel 1/4 in. smaller than duct inside diameter and approximately 20 in. long pulled through each duct, and if any concrete or obstructions are found, Subcontractor shall remove them and clear ducts.

C. Concreting and Forms: All concreting and form work necessary in connection with construction and concreting around plastic and metal duct runs underground shall be provided by this Subcontractor.

D. Removal of Water: Subcontractor shall at all times during construction provide and maintain ample means and devices with which to promptly remove and properly dispose of all water entering excavations or other parts of work and shall keep said excavations dry until all work to be performed therein has been completed.

END OF SECTION 16100

SECTION 16110 - CABLE TRAY SYSTEMS

PART 1 – GENERAL

1.1 SCOPE OF WORK: This Section prescribes the general requirements for CABLE TRAY SYSTEMS. Subcontractor shall furnish, and install the complete cable tray system as specified herein and as shown on the Subcontract drawings.

1.2 The work of this Section is subject to the Fermilab Construction Subcontract Terms and conditions and to Exhibit A, SCHEDULE AND SUPPLEMENTARY TERMS AND CONDITIONS.

1.3 RELATED WORK: Examine all other portions of the Subcontract documents for work related to the work of this Section. Provide all work hereunder as required for the support and accommodation of related work.

1.4 RELATED WORK SPECIFIED ELSEWHERE: The following Sections prescribe items of related Work. Coordinate Work prescribed by this Section with Work prescribed by these Sections:

A. Section 16010 ELECTRICAL – GENERAL PROVISIONS

1.5 APPLICABLE STANDARDS: The publications listed below form part of this Section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the Work included under this Section shall conform to the provisions of these publications:

A. NEMA (National Electrical Manufacturers Association)

1. VE-1 Cable Tray Systems

2. VE-2 Metal Cable Tray Installation Guidelines

B. NEMA (National Electrical Manufacturers Association)

C. UL (Underwriters' Laboratories, Inc.)

1.6 SUBMITTALS: Submittal documentation shall be in accordance with Section 16010 and the following:

A. Physical dimensions and loading capacity of each element in the load chain.

B. Completed product data sheet.

C. General layout and erection drawings indicating plan dimensions and elevations. All supports, hardware and accessories needed for a complete job shall be detailed.

D. Certified test report by an independent agency.

1.7 QUALITY ASSURANCE AND CONTROL:

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and sections shall be required.

PART 2 – PRODUCTS

2.1 The equipment shall consist of a complete rigid cable support system that includes required straight sections, fittings, connectors, accessories, and other items as required for a complete installation.

2.2 MATERIALS:

A. Cable tray shall be fabricated from steel as specified in Paragraph 2.2.C.

B. Steel cable trays and fittings shall be fabricated from steel having a minimum yield strength of 33 ksi.

C. Steel used for fabricating pre-galvanized steel cable trays and fittings shall be continuous rolled hot-dip galvanized in accordance with ASTM A525-G90 - Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, General Requirements.

D. Cable tray splice plates shall be of the same material as the cable trays.

E. Minor auxiliary fittings such as dropout devices, hold-down clips, cover clips, etc., may be fabricated from other compatible materials, if necessary, for purposes of added strength, flexibility, etc.

2.3 FABRICATION AND MANUFACTURE:

A. Inside of cable tray system shall have no sharp edges, burrs, or projections that could cause damage to cables.

B. Each cable tray straight section and each fitting shall be furnished with two splice plates and the required number of fasteners for completing the splice. The strength of the splice joints shall be at least equal to the tray side rails.

C. Cable tray hold down clips shall be furnished with bolts required for fastening to the tray hangers.

D. Flange direction shall be inward and shall be the same for all tray types and fittings.

E. All fittings shall have the same shape and side rail dimensions as the tray straight sections.

F. Cable tray shall be as manufactured by Cooper B-Line, model 248G steel or Fermilab approved equal.

2.4 LOADING AND DEFLECTION REQUIREMENTS: Cable trays shall be designed to the NEMA load/span designation class requirements, as specified in Paragraph 2.6.

2.5 TAGGING: Each cable tray straight section, fitting, cover and hardware container shall be identified by tags.

2.6 CABLE TRAY REQUIREMENTS:

WIDTH	6”	12”	18”	24”
HEIGHT (NOMINAL)	4”	4”	4”	4”
LENGTH	12’-0”	12’-0”	12’-0”	12’-0”
RUNG SPACING	9”	9”	9”	9”
FITTING RADIUS	24”	24”	24”	24”
WORKING LOAD				
STATIONARY LOAD (at mid-span)	200 lbs	200 lbs	200 lbs	200 lbs
NEMA CLASS DESIGNATION	12C	12C	12C	12C
SUPPORT SPAN	10’-0”	10’-0”	10’-0”	10’-0”
DESTRUCTIVE LOAD (12’-0” SPAN)	151 lbs/ft	151 lbs/ft	151 lbs/ft	151 lbs/ft
ALLOWABLE LOAD (12’-0” SPAN)	101 lbs/ft	101 lbs/ft	101 lbs/ft	101 lbs/ft
SAFETY FACTOR	1.5	1.5	1.5	1.5
DEFLECTION	1.02”	1.02”	1.02”	1.02”
DATE OF NEMA CONFORMANCE	1991	1991	1991	1991
TRAY TYPE	Ladder	Ladder	Ladder	Ladder

TRAY MATERIAL	Pre-galvanized Steel	Pre-galvanized Steel	Pre-galvanized Steel	Pre-galvanized Steel

PART 3 – EXECUTION

3.1 Cable trays shall be supported as a maximum of every 10’-0”. The supporting system shall allow for tray expansion as well as tray confinement.

3.2 Expansion couplings and guides shall be provided on straight runs.

3.3 Cable trays shall be bonded and grounded to provide a continuous path for fault current. Materials for grounding shall be compatible with those used for the tray fabrication.

A. Unless noted otherwise on the drawings, a #2AWG bare ground conductor shall be furnished and installed on the outside rail and solidly grounded (using a UL approved ground connector) to each section of cable tray.

B. #2AWG bare ground conductor shall be connected to system ground at a minimum of two (2) places and at distances not greater than 100’-0”.

C. End points of all cable trays shall be connected to the grounding system.

3.4 Cable tray systems shall be complete prior to cable installation.

END OF SECTION 16110

SECTION 16120 - LOW VOLTAGE WIRE AND CABLE – 600-VOLT

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for Low Voltage Wire and Cable - 600V. Subcontractor shall furnish, install, terminate, test and place into operation all low voltage wire and cable, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 16010 – General Electrical Requirements.

B. Section 16080 – Electrical Testing and Inspection.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. ANSI (American National Standards Institute).

B. ASTM (American Society for Testing Material).

C. ICEA (Insulated Cable Engineers Association.

D. IEEE (Institute of Electrical and Electronic Engineers).

E. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).

F. NEMA (National Electrical Manufacturers Association).

G. UL (Underwriters' Laboratories, Inc.).

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12.

A. The following submittal documents shall be furnished prior to equipment installation:

1. Product data for wire and cable.
2. Statement of Section compliance.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 SINGLE CONDUCTOR

A. Conductors:

1. Cable shall consist of a single conductor assembly.
2. Conductors shall be soft-drawn, uncoated stranded copper. Solid conductors are not permitted.
3. Conductor sizes shall be standard American Wire Gauge (AWG) sizes.
4. Minimum conductor size shall be #12 AWG for power (208 VAC and above) and #14 AWG for control (120 VAC and below).
5. Maximum conductor size shall be 500MCM unless otherwise specified.

B. Insulation:

1. Insulation shall be suitable for wet or dry locations.
2. The insulation shall have a minimum rating of 90°C for dry locations, 75°C for wet locations, and 250°C short circuit conditions.
3. Insulation shall be rated 90°C, 600-Volt, Type THWN/THHN in accordance with NFPA.

C. Tagging: The following minimum information shall be printed on the surface of the insulation at regular intervals:

1. Conductor size.
2. Voltage class.
3. Type of insulation.
4. Manufacturer’s name.
5. Marking to indicate UL listing.

2.02 MULTI-CONDUCTOR CONTROL CABLE

A. Conductors:

1. Conductors shall be soft-drawn, uncoated stranded copper. Solid conductors are not permitted.
2. Conductor sizes shall be standard American Wire Gauge (AWG) sizes.
3. Minimum conductor size shall be #14 AWG.

B. Insulation:

1. Insulation shall be suitable for wet or dry locations.
2. Insulation type shall be SO (60°C) for ambient temperatures less than 50°C and shall be FEP Teflon (200°C) for ambient temperatures

greater than 50°C. For other location insulation and jackets shall be 90°C, 600-Volt, Type THHN in accordance with the NFPA.

3. Insulation shall be rated 600-Volt.

C. The following minimum information shall be printed on the surface of the insulation at regular intervals:

1. Conductor size.
2. Voltage class.
3. Type of insulation.
4. Manufacturer's name.
5. Marking to indicate UL listing.

PART 3 EXECUTION

3.01 Cable shall not be bent to radius smaller than that specified by the manufacturer or by the NEC. Special pull boxes or oversized conduits shall be utilized to meet this requirement.

3.02 No conductors or cables shall be installed in the conduits, ducts or raceway system until the system has been completed.

3.03 All panelboard feeder cables shall be continuous from the point of origin to the panelboard without splices.

3.04 All cables shall be continuous from point of origin to the required destination. Where splices are noted on the drawings, they shall be in suitable splice boxes with suitable connectors.

3.05 Unless noted otherwise, each conduit raceway shall contain only those conductors constituting a single feeder circuit.

3.06 Cable terminations and their conductor connections shall be in accordance with the drawings. Conductor insulation shall be squarely and evenly cut. Length of exposed conductor shall provide maximum conductor contact while maintaining conductor insulation continuous with the connector. Control wiring termination shall be made using insulated sleeves and crimp type spade lugs for all devices equipped with screw terminals. Nema 2-hole lugs shall be used for pad terminal connections.

3.07 Cables shall be neatly trained, without interlacing, and shall be pulled with sufficient length in all boxes, equipment, and panels to permit making a neat arrangement. Jackets of multi-conductor control and instrument cables shall be properly removed to train and terminate the conductors. Cables shall be secured in a manner to avoid tension on conductors or terminals, and protected from mechanical injury and moisture at the exposed end. Sharp bends over conduit bushings are prohibited.

3.08 Damaged cables or conductors shall be removed and replaced at the expense of the Subcontractor.

3.09 Cable terminations shall be performed by certified craftsmen working in complete conformance with the manufacturer's instructions.

3.10 Cable terminals, taps, or splices shall be made with solderless pressure type connectors, unless otherwise specified.

3.11 Compression type connectors shall be installed with an approved hydraulic tool such that a permanent, mechanically secure, high conductive joint is achieved.

3.12 For conductors connected to metal surfaces, the coated surface of the metal shall be polished before installing the conductor. Lacquer coating on conduits shall be removed where ground clamps are installed.

3.13 Cable pulling compounds shall not contain microball spheres, ethylene glycol or mineral oil. Acceptable pulling compound shall be as manufactured by American Polywater Corp. (PolywaterJ) or Fermilab approved equal.

3.14 Each cable or conductor group in panels, pull boxes or wireways shall have a permanent tag with suitable numbers and letters for easy identification. Control wiring shall be neatly laced, bundled, and identified by typewritten heat-shrinkable tubing labels on each conductor termination.

3.15 Cables shall be tested and inspected in accordance with Section 16080: - Electrical Testing and Inspection.

3.16 COLOR CODING

A. Cable shall be color coded by integral pigmentation with a separate color for each phase and neutral used consistently through out the system. Color coded markings or tags at place of origin and termination is not acceptable.

B. For cables sized #10 AWG and larger, all conductors may be black. For multiconductor cables, #10 AWG or larger, each insulated cable shall be color-coded according to ICEA standards.

C. Voltage levels, grounded conductors, equipment grounding conductors, and ungrounded phase conductors shall be identified by the following color coding system:

1. 120/208 VAC 3-Phase Systems:
   a. Grounded neutral: White.
   b. Grounding conductor: Green or bare.
   c. ØA (ungrounded) conductor Black.
   d. ØB (ungrounded) conductor: Red.
   e. ØC (ungrounded) conductor: Blue.
2. 277/480 VAC Three Phase Systems:
   a. Grounded neutral: Gray.
   b. Grounding conductor: Green or bare.
   c. ØA (ungrounded) conductor: Brown.
   d. ØB (ungrounded) conductor: Orange.
   e. ØC (ungrounded) conductor: Yellow.

END OF SECTION 16120

SECTION 16125 - 15KV CABLE INSTALLATION

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This Section prescribes the general requirements for 15kV CABLE INSTALLATION. Subcontractor shall furnish the materials, installation, terminating, splicing, testing and all related work for the complete and functional 15kV cable system, as specified herein and as shown on the Subcontract drawings.

B. This Section prescribes the general requirements for 15kV switches and 15kV-480V transformer installation. Subcontractor shall furnish the removal, installation, connection, testing and all related work for the complete and functional 15kV distribution system, as specified herein and as shown on the Subcontract drawings.

C. Connection of ground conductors to the electrical equipment shall be included as part of this Work.

D. The drawings and Sections are meant to complement each other; however, in case of conflicts, the sections shall govern, since they are intended to identify all materials and equipment required for the construction of the facility. Any deviation from the Sections or drawings shall be authorized by the Fermilab Construction Coordinator prior to purchase or installation.

E. Any apparatus, appliance, material, or work not shown on drawings or indicated in the Sections, but necessary to make the work complete and ready for operation shall be furnished, delivered, and installed by Subcontractor without additional expense to Fermilab.

1.2 The work of this Section is subject to the Fermilab Construction Subcontract Terms and conditions and to Exhibit A, SCHEDULE AND SUPPLEMENTARY TERMS AND CONDITIONS.

1.3 RELATED WORK: Examine all other portions of the Subcontract documents for work related to the work of this Section. Provide all work hereunder as required for the support and accommodation of related work.

1.4 RELATED WORK SPECIFIED ELSEWHERE: The following Sections prescribe items of related Work. Coordinate Work prescribed by this Section with Work prescribed by these Sections:

A. Section 16100 – Ductbank

1.5 APPLICABLE STANDARDS: The publications listed below form part of this Section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the Work included under this Section shall conform to the provisions of these publications:

A. ANSI (American National Standards Institute)

1. ANSI C2 (National Electrical Safety Code)

B. ICEA (Insulated Cable Engineers Association)

C. IEEE (Institute of Electrical and Electronics Engineers)

D. NEMA (National Electrical Manufacturers Association)

E. NETA (National Electrical Testing Association)

F. NFPA (National Fire Protection Association)

1. NFPA 70 (National Electrical Code)

G. OSHA (Occupational Safety and Health Administration)

H. UL (Underwriters' Laboratories, Inc.)

1.6 SUBMITTALS: The following submittal documents shall be furnished prior to equipment installation:

A. Physical dimensions and weights.

B. Connection diagrams.

C. Certified test reports.

D. Certificate of NEMA compliance.

E. Statement of Section compliance

F. As-Built Drawings:

1. A complete set of electrical drawings shall be maintained by the Subcontractor at the job-site for "as-built" records. These prints shall be corrected daily to show any deviations from the subcontract drawings, accurately indicating locations of all splices and actual installed cable lengths. A legible set of these "as-built" drawings shall be submitted to the Fermilab Construction Coordinator at the completion of the Subcontract.

G. Submittals shall be in accordance with EXHIBIT A, Section 12.0: Submittals, Shop Drawings and Material Samples and the following:

1. At least ten (10) days prior to the procurement of the equipment or material or installation thereof, and at most thirty (30) days after Subcontract award, Subcontractor shall submit a type written list of all items of equipment and material proposed for the project. The list shall set forth the Section page number, manufacturer's name, model number, size, non-standard accessories specified or required and any

other information required to identify each item. If substitutions have been offered in lieu of the specified materials and/or equipment, complete descriptive literature for those substitute items shall be submitted. Substituted items shall require approval by Fermilab.

1.7 QUALITY ASSURANCE AND CONTROL:

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and sections shall be required.

C. Only firms regularly engaged in the construction and installation of medium voltage cable installations and terminations and who have their systems in satisfactory use in similar service for at least ten (10) years shall be considered acceptable Subcontractors.

D. Performance Guarantee:

1. Installation of electrical systems shall be completed to the satisfaction of Fermilab Construction Coordinator. The Subcontractor, at no additional cost to the Fermilab, shall correct work performed by the Subcontractor judged not to be to the satisfaction of the Fermilab Construction Coordinator.
2. It shall be the sole responsibility of the Subcontractor that the electrical systems are installed to the satisfaction of Fermilab.
3. Subcontractor shall guarantee all equipment, material, and installation provided by Subcontractor to be free from defects.
4. Subcontractor shall assign persons in direct charge of the work who are thoroughly experienced in the class of construction required. All labor shall be performed in a workmanlike manner by skilled workmen under supervision of a competent foreman.

PART 2 – PRODUCTS

2.1 MATERIAL FURNISHED BY FNAL: The following material will be furnished by FNAL and installed by the Subcontractor. Subcontractor shall be responsible for off-loading of material, installation, terminating, splicing and testing of the cables, unless noted otherwise. Information describing equipment included in this section is intended as an approximate scope of the work and is not intended to be detailed itemization of all work to be performed as a part of these sections.

A. Medium Voltage Power Cable:

1. 750MCM, 15kV, EPR, triplexed, aluminum, shielded cable with jacketed concentric copper neutral conductors, 100% insulation level. Cable will be furnished by Fermilab on reels located at the Fermilab Railyard Storage area.
2. Subcontractor shall transport cable from the Fermilab Railyard Storage area to the work area for installation. Subcontractor shall be

responsible for all transportation requirements. All reels shall be returned to the Fermilab Railyard Storage area.

B. 15kV Primary – 480V Secondary Transformers (By Owner):

1. Transformers (tagged “TR-Mu2e-A” & “TR-Mu2e-B”) will be furnished by FNAL.
2. Each transformer will have the following ratings: Nominal system primary voltage and configuration: 15kV, 3ph, 3w Nominal system secondary rating and configuration: 277Y / 480V, 3ph, 4w.

C. 15kV Disconnect Switches (By Owner):

1. 15kV, 4-way disconnect switches “DSTR-Mu2e-1” will be furnished by FNAL. The disconnect switches will be furnished with the following ratings

Nominal system voltage:	15kV
Current rating:	600A
Manufacturer:	S & C PMH-10

2. 15 kV, 1-way disconnect switch “DSTR-Mu2e-2” will be furnished by FNAL. The disconnect switches will be furnished with the following ratings

Nominal system voltage:	15kV
Current rating:	600A
Manufacturer:	Autojet II Load Interrupter Switch with 120VAC motor operator (120V control power from external source)

D. Power Manholes (PMH):

1. Subcontractor shall be forewarned that:
   a) Cable supports in existing manholes have deteriorated.
   b) Removal and installation of cables in existing manholes will be difficult due to the number and routing of existing cables.
   c) All manholes should be assumed to full of water and pumping will be required.
   d) Adjacent feeders in the manholes will be energized. Subcontractor agrees that work can be performed in manholes with energized adjacent feeders. NO EXCEPTIONS.

E. Electrical Equipment:

1. Fermilab will perform any and all cable de-energization. Sub-contractor is prohibited from performing any circuit breaker switching.

2.2 MATERIAL FURNISHED BY SUBCONTRACTOR: Except as designated as furnished by Others, Subcontractor shall furnish all supervision, labor, material, tools, equipment, testing devices, machinery, consumables and other items necessary for a complete and workable installation. All materials furnished by the Subcontractor

shall be new and shall be subject to review and approval by the Fermilab Construction Coordinator.

A. Medium Voltage Power Cable:

#4/0 AWG, 15 kV, EPR, single aluminum, shielded cable with jacketed, 1/3 concentric copper neutral conductors, 133% insulation level.

Manufacturer: Okonite, Model: 162-23-3081

B. Terminal Lugs:

1. Subcontractor shall furnish and install lugs for the termination of power cables at electrical equipment (except oil switch terminations). Terminal lugs shall be un-insulated, aluminum compression terminal with NEMA 2-hole pattern. Lugs shall be suitable for aluminum cable and shall be as manufactured by Burndy. Terminal lugs shall be as follows:

a)	Conductor Size:	750 MCM	4/0 AWG
	Straight Connector:	YA39AM2	YA28A5
	Angle (45°) Connector:	YA39AM2-45	YA28A5-45

C. Termination Kits-Air:

1. Termination kits for new air switches or transformer terminations shall be 3M Company Cold Shrink QT lll Termination Kits and as follows:

15kV Concentric and jacketed Concentric Cable Kits:

Conductor Size:	500 -1000 MCM
Conductor Insulation O.D. Range:	1.05”-1.80”
Indoor Kit Number:	7645-T-110
Outdoor Kit Number:	7655-S-4
Conductor Size:	#2-#4/0; 2/0-300 MCM
Conductor Insulation O.D. Range:	0.64”-1.08”; 0.72”-1.29”
Indoor Kit Number:	7642-T-110
Outdoor Kit Number:	7653-S-4

2. Outdoor kits shall be utilized when the termination is exposed to the weather.

3. Termination kits shall be furnished and installed by Subcontractor. Subcontractor shall exercise extreme care in conductor preparation and insulation strip lengths.

D. Cable Splice Kits:

1. Cable splice kits shall be as manufactured by Elastimold as follows:

a) In-Line Splice Kits:

Conductor Size:	750 MCM
Conductor Size Range:	1.370”-1.630”
Splice Kit Number:	650S-M0380-M0380

b) Wye Splice Kits:

Conductor Size:	750 MCM
Conductor Size Range:	1.370”-1.630”
Splice Kit Number:	656CY-M0380

2. Splice kits shall be furnished and installed by Subcontractor and shall exercise extreme care in conductor preparation and insulation strip lengths.

3. Subcontractor shall coordinate with Fermilab Construction Coordinator before splicing existing cables.

E. Raceways and Concrete Pads:

1. Subcontractor shall furnish and install 15kV concrete encased, electrical duct banks in accordance with Section 16100: DUCTBANK and as shown on the Subcontract drawings.

F. Core Drills:

1. Subcontractor shall provide all requirements for the core drilling of existing manholes where duct terminators are not available.
2. Subcontractor shall:
   a) Furnish and install conduit end bells for all conduits terminating in a manhole. End bells shall be grouted with lean grout.
   b) Furnish a sketch of proposed locations of all core drills to the Fermilab Construction Coordination prior to the beginning of any many manhole cores.

G. Firewrapping:

1. All power cables in manholes and cable vaults shall be suitably protected against fire. Entire length of exposed cable in the manhole (including splices and/or wye splices) shall be fire wrapped. Cable firewrapping shall be furnished and installed by the Subcontractor.

2. Firewrapping shall be as manufactured by 3M Company (3M-77) or Fermilab approved equal.

H. Grounding Materials:

1. Bonding and grounding conductors shall be ASTM B1 solid, bare copper for sizes #8AWG and smaller and shall be ASTM B8 Class B stranded copper for sizes #6AWG and larger.

PART 3 – EXECUTION

3.1 All bus, insulators and other exposed hardware shall be cleaned by the Subcontractor.

3.2 Subcontractor shall take the necessary construction and safety precautions during the installation of the new cables in the manholes or other areas where the energized feeders are located.

3.3 The drawings indicate the general layout of the electrical systems, arrangement of feeders, substations, and other work. Electrical plans are by nature diagrammatic.

A. Subcontractor shall bring to Fermilab's attention any discrepancies between the drawings and the "As-Constructed" conditions. Subcontractor shall not deviate from the drawings without written approval from the Fermilab Construction Coordinator.

B. Subcontractor shall verify the location and method for connecting to each item of equipment.

C. Subcontractor shall install equipment and material in accordance with the Subcontract requirements. Materials or equipment improperly installed shall be removed and reinstalled to the satisfaction of Fermilab Construction Coordinator, at Subcontractor's expense

D. All cables shall be routed for ease of maintenance, serviceability, and installation of future cables.

E. Whenever possible, cables routed in manholes shall enter and exit the manholes penetrations through corresponding conduits on the opposite sides of the manhole.

3.4 CABLE REEL MOVEMENT:

A. Reels of cable shall not be dropped from any heights. Particular care shall be exercised when handling reels from trucks or other transporting equipment.

B. Reels shall be lifted utilizing the following methods:

1. When using a crane or boom type equipment, insert a heavy rod or pipe through the reel hub and lift with slings on shaft, preferably using a spreader bar or yoke to reduce or avoid side pressure against the reel flange.

2. Fork lift type equipment may be used to move smaller, narrower width reels. Fork tines shall be placed such that the lift pressure is on the reel flange and not on any part of the cable and the tines shall reach across the reel on both flanges of the reel.

3. Reels may be rolled short distances by rolling. Reels shall be rolled in the direction of the arrows marked on the reel flanges. Surfaces over which the reels are rolled shall be firm, clear of debris, and clear of protruding stones, humps, etc. which might otherwise damage the cable.

3.5 CABLE STORAGE:

A. Should the cable end seals be damaged or removed, Subcontractor shall install new seals to prevent entry of moisture. Cable seals shall be sealed using RayChem heat shrink end seals.

B. Whenever possible, factory installed lagging (protective cover), if provided, shall be left in place. Additional covering shall be provided and installed by the Subcontractor if the cable reels are stored outdoors for excessively long periods (more than seven calendar days) or in dirty or dusty areas.

C. Cable reels shall be stored on a firm surface with planking to prevent settling of the cable reels into soft ground.

D. Any area of cable reel storage shall have adequate drainage. Subcontractor shall relocate any and all cable reels located in areas of inadequate drainage.

1. Fencing or other barriers shall be provided by the Subcontractor to protect reels against damage.

3.6 CABLE PLACEMENT:

A. Conductor/cable installation shall be in accordance with the cable manufacturer's recommendations and the following requirements:

1. Cable shall not be handled when the cable temperature is below 32°F (0°C). If cable heating is required prior to placement, the cable shall be stored in a heated building in accordance with the manufacturer's recommendations for a minimum of 24 hours. Cable shall be pulled the same day it is removed from the heated storage. Subcontractor shall provide temporary shelter and heating for cables and reels.
2. If at any time during the progress of the work the Subcontractor finds raceways that appear inadequate to accommodate the assigned cable, he shall notify Fermilab at once and shall discontinue any further work on the questionable raceway until advised by Fermilab as to how to proceed.
3. Immediately prior to the placement of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cable assigned to a particular conduit shall be grouped and pulled in simultaneously using cable grips and acceptable lubricants.
   a) Subcontractor shall pull an appropriate sized mandrel through conduits prior to pulling any cables.
4. All cable shall be carefully checked both as to size and length before being pulled into conduits. Cable pulled into the wrong conduit or cut too short to rack, train, and splice as specified herein shall be removed and replaced by and at the expense of the Subcontractor. Cable removed from one conduit shall not be pulled into another conduit.

3.7 CABLE PULLING:

A. Damaged cable shall be removed and replaced by and at the expense of the Subcontractor.

B. Pulling eyes on conductors or a basket weave grip shall be used for pulling cable. Woven wire cable grips shall be used to pull all single conductor cable where pulling eyes are not available. All sharp points and edges on the hardware attaching the pulling rope to the cable shall be taped to prevent snagging or damaging the raceway. Pulling eye only shall be utilized for pulling of 15kV 750kcmil cables.

C. When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal plus 6” shall be cut off and discarded when the pull is completed. When pulling loops are used, the entire loop shall be cut off and discarded when the pull is completed.

D. A nonfreezing type of swivel, or swivel connection, shall be inserted between the pulling rope and the cable pulling eye, grip, or loop to prevent twisting under strain and to allow for free rotation of the cable during pulling.

E. Cable pulling compounds shall not contain microball spheres, ethylene glycol or mineral oil. Acceptable pulling compound shall be as manufactured by American Polywater Corp. (Polywater J) or Fermilab approved equal.

F. As soon as the cable is pulled into place, the pulling eyes, cable grips, or pulling loops shall be removed. Any cable which was scaled shall be resealed.

1. Cables pulled with ends pulled to a point above normal grade elevation shall be resealed with a minimum of three (3) wraps of 2” Scotch #23 (or Fermilab approved equal) rubber splicing tape. Exposed cables ends shall be carefully wrapped in such a manner as to prevent unintentional water entry from weather exposure. Exposed cable ends shall be wrapped prior to the end of the work day.
2. Cables pulled with ends pulled to a point below normal grade elevation (manholes or vaults) shall be resealed with appropriately sized RayChem heat shrink end seal boots. Exposed cables ends shall be sealed in such a manner as to prevent unintentional water entry from weather or water filled manholes or vaults. Exposed cable ends shall be sealed prior to the end of the workday.

3.8 PULLING TENSION:

A. The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Subcontractor shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected.

3.9 Sidewall Pressure:

A. To avoid insulation damage from excessive sidewall pressure at bends, the pulling tension in pounds at a bend shall not exceed 300 times the radius of the bend in feet.

3.10 CABLE BENDS:

A. Cable shall not be bent to a radius of less than 12 times the overall cable diameter.

3.11 HI-POT TESTING:

A. All cables shall be tested in accordance with the requirements of Section 16080: ELECTRICAL TESTING AND INSPECTION.

B. Hi-pot test voltages shall be as follows, unless directed otherwise by the Fermilab Construction Coordinator:

1. 15kV Unjacketed Cable: 65kV in 10 increments of 6500V.
2. 15kV Jacketed Cable: 55kV in 10 increments of 5500V.

C. Cable testing shall be performed under this Subcontract and shall meet the requirements of NETA (National Electrical Testing Association). See Section 16080: Electrical Testing and Inspection for cable testing parameters and requirements to be provided under this Subcontract.

3.12 TERMINATIONS:

A. Cable shall be terminated in accordance with the following requirements:

1. Cable shall be neatly trained in place and cut squarely to the required length. Sharp bends shall be avoided.
2. Remove necessary amount of cable jacket and insulation without damage to the conductor.
3. Install terminals or terminal connectors as required, ensuring a firm metal-to-metal contact.

3.13 CABLE SUPPORTS-GENERAL:

A. Cable supports and securing devices shall be installed to provide adequate support without deformation of the cable jackets or insulation.

B. Adequate cable end lengths shall be provided and properly placed in manholes to avoid longitudinal strains and distorting pressures on the cable.

C. Cable routing in manholes shall be subject to the approval of the Fermilab Construction Coordinator.

1. Cables shall be routed within the manhole such that adequate working space is provided within the manhole for cable splicing and for the installation of future cables.

D. Cables shall be tied through the use of cable ties, however, installation shall not impede horizontal movement of cables during ambient variations and short circuit forces.

E. Final inspection shall be made after all cable is in place and, where supports or raceway fittings deform the cable jacket, additional supports shall be provided as directed by Fermilab. Additional cable protection such as a wrapping of light rubber belting, friction tape or similar material shall be provided where required.

3.14 LACING:

A. Nylon ties shall be used to neatly lace together conductors entering manholes, handholes and similar locations after the conductors have emerged from their raceway.

3.15 GROUNDING:

A. Concentric neutrals shall be grounded at all splice points and at all termination points.

B. Concentric neutrals shall be pulled back, twisted together and connected to the grounding conductor using a compression type ground lug.

C. Concentric neutral from splice or termination shall be grounded to the system ground through the use of a #2/0AWG bare copper ground cable.

D. Ground conductors shall not be looped between pieces of cable. Each cable ground point shall have a direct connection to the ground system.

E. All contact surfaces shall be thoroughly cleaned of dirt or oil.

F. Grounding circuit connections shall be such that grounding resistance may be checked at anytime.

3.16 CABLE IDENTIFICATION:

A. Subcontractor shall identify furnish and install cable identification markers near each termination point and at each manhole or handhole of all conductors.

B. Each cable shall bear the number of the circuit and the “from” - “to” routing of the cable. For example:

FDR 31
PHP P-115 TO MS2

Nameplate engraving shall be subject to the approval of the Fermilab Construction Coordinator.

C. All cables shall be identified with machine engraved lamocoid nametags with white letters on red background and shall be firmly attached to the cable with non-metallic cable ties.

D. Each nameplate shall be provided with a ¼" diameter hole for securing the nameplate to the cable.

E. Nametags shall be approximately 1½" wide and of sufficient length to accommodate the lettering requirements. Lettering shall be as follows:

First line (Feeder number): ½" lettering.
Second line (From-To): ⅜" lettering.

F. Phase identification tags shall be provided at all termination points. Phase identification shall be as follows:

1. A Ø (Ungrounded conductor): Black
2. B Ø (Ungrounded conductor): Red
3. C Ø (Ungrounded conductor): Blue

3.17 CABLE AND CABLE REEL DISPOSITION:

A. Any cable removed from posted radiological areas shall remain the property of Fermilab.

1. Subcontractor shall coordinate removed of cable for with the Fermilab Construction Coordinator for the determination of posted radiological areas.
2. All other excess (removed) aluminum or copper cable shall be considered scrap and shall become the property of the Subcontractor. Subcontractor shall be responsible for the disposal of such cable.

B. Subcontractor shall return steel cable reels to the railyard storage area. Fermilab will return the empty reels to the Manufacturer at the end of the Subcontract for reel deposit.

1. Empty wood cable reels shall be demolished and disposed by the Subcontractor.

END OF SECTION 16125

SECTION 16130 - RACEWAYS AND BOXES

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for Raceways and Boxes. Subcontractor shall furnish, install, terminate, test and place into operation all material, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 16010 – General Electrical Requirements.

B. Section 16060 – Grounding and Bonding.

C. Section 16080 – Electrical Testing and Inspection

D. Section 16120 – Low Voltage Wire and Cable – 600-Volt.

E. Section 16140 – Wiring Devices.

F. Section 16442 – Panelboards.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications.

A. ANSI (American National Standards Institute):

1. ANSI C2 (National Electrical Safety Code).

B. ICEA (Insulated Cable Engineers Association).

C. IEEE (Institute of Electrical and Electronics Engineers).

D. NEMA (National Electrical Manufacturers Association).

E. NETA (National Electrical Testing Association).

F. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).

G. OSHA (Occupational Safety and Health Administration).

H. UL (Underwriters' Laboratories, Inc.).

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials shall be of the highest quality, exhibiting no flaws or mechanical deficiency, and shall bear the UL label where applicable. Where products or materials are specified by brand or trade name, substitution of an approved equal is acceptable only upon written authorization by the Fermilab Construction Coordinator.

B. Wherever practical, all equipment of a similar type shall be of the same type and manufacturer. For example, all panelboards and breakers shall be of the same manufacturer. This shall apply to, but not be limited to, panelboards, circuit breakers, motor starters, lighting fixtures, and wiring devices.

2.02 RACEWAYS: The following are considered standard conduit sizes and only such sizes shall be used: 3/4 in., 1 in., 1-1/2 in., 2 in., 3 in., 4 in., and 5 in. Use rigid steel conduit.

A. RMC: Rigid Steel Conduit.

B. IMC: Intermediate Metallic Conduit.

C. EMT: Electric Metallic Tubing.

D. Rigid steel conduit shall be hot dipped, galvanized with zinc or enamel coating. Shepardizing, electro-plating or spraying is unacceptable. Conduit shall conform to ANSI C80.1 for rigid steel conduit and ANSI C80.6 for intermediate metal conduit. Acceptable manufacturers: Allied, Triangle, PWC, Wheatland.

E. All 5 in. conduits shall have a 48 in. minimum bending radius, unless noted otherwise on the drawings.

F. Conduit couplings shall conform to the same specifications as conduit and be of the same manufacturer as the conduit. Threadless fittings shall not be utilized.

G. Conduit elbows shall conform to the same specifications as conduit and be of the same manufacturer as the conduit. Field bent and/or factory supplied elbows shall be oversized.

H. Factory made nipples shall be galvanized steel and conform to Federal Standard WWC-58.

I. Locknuts shall be plated, malleable iron. Acceptable manufacturers: T & B, Steel City, Appleton.

J. Bushings shall be metallic type with insulated inserts. Acceptable manufacturers: T & B, Steel City, Appleton, O.Z.

K. Unions (Erickson fittings) shall be plated malleable iron. Split couplings shall not be utilized. Acceptable manufacturers: T & B, Steel City, Appleton.

2.03 LIQUID-TIGHT FLEXIBLE CONDUIT

A. Liquid tight flexible conduit shall be flexible, galvanized steel core, with an oil resistant, outer polyvinyl chloride jacket. Acceptable manufacturers: Anaconda, Carol, Electri-Flex.

B. Liquid tight flexible conduit connectors shall be steel, insulated throat type with ground cone. If used in the termination of an unthreaded hole, a neoprene inches O in. ring shall be installed to insure a liquid tight seal. Acceptable manufacturers: T&B, Appleton.

2.04 FLEXIBLE STEEL CONDUIT (GREENFIELD)

A. Flexible steel conduit (Greenfield) shall be galvanized steel. Acceptable manufacturers: Carol, Southwire, Triangle, PWC.

B. Flexible steel conduit (Greenfield) fittings shall be insulated throat type inchtite-bite inches Acceptable manufacturers: T & B or approved equal.

C. Flexible steel conduit (Greenfield) combination couplings shall be inchtite-bite inch. Acceptable manufacturers: T & B or approved equal.

2.05 PULL BOXES

A. Pull boxes shall be manufactured of galvanized steel, and be of metal gauge and physical size as required by the NEC for the number and size of conductors and conduits involved.

B. Pull boxes shall have removable screw covers for surface and flush mounting with silicon bronze corrosion resistant screws.

C. Cast boxes shall be utilized for outdoor or wet locations.

2.06 JUNCTION BOXES AND OUTLET BOXES

A. In general, junction and outlet boxes shall not be sized smaller than allowed per the NEC.

B. Junction and outlet boxes shall not be smaller than 2-1/8 in. in depth for all 120/208 VAC applications:

1. Extension rings shall be provided as required.
2. Square junction and outlet boxes: 4 in. square, when used, shall be Raco 230, 231, 232, 233 or Fermilab approved equal.
3. Junction and outlet boxes shall be provided with covers, Raco 752 or Fermilab approved equal.

C. Junction and outlet boxes for 277/480 VAC for power, lighting or motor circuits shall be a minimum of 4-11/16 in. square and a minimum of 2-1/8 in. deep. Junction and outlet boxes shall be Raco 255, 256, 257, 258, 259, 265 or Fermilab approved equal.

D. Larger junction boxes shall be sized in accordance with the NEC and shall be as manufactured by Keystone, Hoffman or Fermilab accepted equal.

E. Junction and outlet boxes shall be suitable for surface installation or flush mount as noted on the drawings.

F. Deep style cast boxes shall be utilized for outdoor / wet locations, or indoor locations as shown.

PART 3 INSTALLATION

3.01 GENERAL INSTALLATION CRITERIA

A. Subcontractor shall install all conduit systems as shown on the drawings.

B. All exposed conduit shall be Intermediate metal conduit, unless noted otherwise. All direct buried conduit shall be rigid galvanized steel conduit, unless noted otherwise.

C. Conduit shall be cut square, ends reamed and with sharp, clean-cut threads. Conduit size shall be as indicated on the drawings. Field bend conduit shall have a minimum radius as indicated in Table 2, Chapter 9 of the NEC. The radius of bend shall be taken as the radius of curve at the inner edge of the elbow. Conduit shall maintain a uniform circular cross section throughout the bend.

D. Subcontractor shall be responsible to determine conduit lengths. If conduits change elevation when entering or leaving the main conduit route, they shall not interfere with piping or block space designated for future use. Subcontractor shall provide pull points required to limit the number of bends in any conduit run in accordance with Articles 344, 348, and 350 of the NEC.

E. Subcontractor shall swab clean conduit runs by pulling an appropriate sized mandrel through the conduit before installation of wire or cable for conduit sized 2 in. and larger.

F. Subcontractor shall protect all conduits during construction. Openings in the conduit system shall be plugged or capped to prevent entrance of moisture

or foreign matter. Subcontractor shall replace, at no expense to Fermilab, conduits and ducts containing foreign materials, which cannot be removed.

G. All conduit and conduit fittings shall have a minimum of five (5) threads fully engaged at all connections. Threadless conduit fittings are prohibited.

H. All conduits sized 2 in. and above shall contain a 1/4 in. nylon pull rope, including those conduits with conductors.

I. All raceways passing through floors shall pass through cored holes having an internal diameter of 1/2 in. larger than the outside diameter of the raceway. In floor cores, the gap between the core and the raceway shall be filled with inches Duxseal in. or a Fermilab accepted equal.

J. All marred raceway surfaces and field cut threads extending beyond couplings shall be retouched with an accepted, lead free paint.

K. Concealed and for voltage 120/208V or up to 277V shall be EMT and up to 2” C, IMC: 2” to 6” and larger.

L. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC and use LFMC in damp or wet locations.

M. Damp, Wet Locations: Rigid steel conduit.

N. Stub up conduit above grade: Rigid steel conduit.

3.02 CONDUIT SUPPORTS AND ROUTING

A. Vertical and horizontal runs of conduit shall be secured and supported at intervals in accordance with the NEC Article 342.30 (A)&(B), 344.30 (A)&(B), 352.30 (A)&(B), and 358.30 (A)&(B).

B. In general, conduit supports shall consist of hot dipped galvanized Unistrut type slotted channels with suitable clamps and bolts. Channels shall be securely welded or clamped to the structural steel.

C. Supporting conduits from piping is not permitted unless specifically shown on drawings.

D. Exposed conduit shall be routed parallel to or at right angles to all walls, ceilings, columns and beams. Conduit shall be routed a minimum of 1/4 in. off the walls, ceilings, columns and beams.

E. All conduits shall be routed for maximum practical accessibility of junction boxes and conduit fittings.

3.03 CONDUIT FITTINGS

A. Gaskets shall be utilized for all fittings.

B. Conduit bushings shall be installed where wiring leaves the conduit system.

C. Unused holes or knockouts shall be plugged.

3.04 FLEXIBLE CONDUIT SYSTEMS

A. Final connections to motors, wall or floor mounted transformers (primary and secondary connections), space heaters or other vibration generating devices shall be terminated through use of liquid tight flexible conduit to avoid transmission from the device to the conduit system.

B. Maximum length of liquid tight flexible conduit shall be 36 in.

3.05 PULL BOXES

A. Pull boxes shall be furnished and installed as required to facilitate conductor installation. In general, conduit runs in excess of more than 100 ft - 0 in. or with more than three (3) right angle bends (270 degrees) shall have a pull box installed at a convenient, intermediate location.

B. Pull boxes shall be securely mounted to the building structure independent of the conduits entering or exiting the boxes.

C. All pull boxes shall be shown on the inches as-built inch drawings.

3.06 JUNCTION BOXES AND OUTLET BOXES

A. Junction and outlet boxes shall be furnished and installed as required to terminate, tap off or redirect multiple conduit runs.

B. Junction and outlet boxes shall be sized per the NEC on the number and size of conduits and conductors exiting the box.

C. Intermediate cable supports shall be provided and installed, as required due to box dimensions. Supports shall have insulated, removable cross supports.

D. Junction and outlet boxes containing splices shall provide ample working space for cutting, splicing and sealing conductors.

E. Junction boxes shall be equipped with steel barriers, as indicated on the drawings, to isolate circuits of different voltages.

F. Junction and outlet boxes shall be securely mounted to the building structure independent of the conduits entering or exiting the boxes.

G. Junction boxes shall be supported independently of conduits entering or exiting the boxes. Brackets, rod hangers, bolts or other suitable methods shall be utilized.

H. The location of outlets shown on the drawings is schematic only. Coordinate exact locations with building details, equipment connection requirements, and work of other Subcontractors. Fermilab Construction Coordinator may alter the location of outlets shown within a 6-ft radius prior to installation.

END OF SECTION 16130

SECTION 16140 - WIRING DEVICES

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for Wiring Devices. Subcontractor shall furnish, install, terminate, test and place into operation all wiring devices, as specified herein, and as shown on the subcontract drawings.

1.02 RELATED WORK: The following section includes items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 16010 – General Electrical Requirements.

B. Section 16120 – Low Voltage Wire and Cable – 600-Volt.

C. Section 16130 – Raceways and Boxes.

1.03 APPLICABLE STANDARDS: The organizations listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these organizations.

A. ANSI (American National Standards Institute).

B. IEEE (Institute of Electrical and Electronics Engineers).

C. NEMA (National Electrical Manufacturers Association)

1. Standard WD1.

D. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).

E. UL (Underwriters' Laboratories).

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12.0.

A. The following submittal documents shall be furnished prior to equipment installation:

1. Product data for wiring devices.

1.05 QUALITY ASSURANCE AND CONTROL:

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials shall be of the highest quality, exhibiting no flaws or mechanical deficiency, and shall bear the UL label where applicable. Where products or materials are specified by brand or trade name, substitution of an approved equal is acceptable only upon written authorization by the Fermilab Construction Coordinator.

B. Wherever practical, all equipment of a similar type shall be of the same type and manufacturer. For example, all panelboards and breakers shall be of the same manufacturer. This shall apply to, but not be limited to, panelboards, circuit breakers, motor starters, lighting fixtures, and wiring devices.

2.02 SWITCHES

A. All switches shall be from the same manufacturer and have identical physical appearance and characteristics.

B. Lighting and general purpose switches shall be rated 20A, 120/277-Volt.

C. Switches shall be suitable for back and/or side wiring terminations with terminal screws and clamp terminals for up to #10 AWG copper or aluminum conductors.

D. Switch housings shall be heavy grade urea or ceramic, ivory color.

E. Switches shall be smooth action, silent, and utilize permanently lubricated toggle mechanism with silver alloy contact buttons.

F. All covers for wiring devices housing switches shall be of the metallic type. Plastic covers are unacceptable.

G. The following standard receptacles or their equivalent shall be used as indicated on the drawings, complete with boxes, and associated hardware:

1. Single Pole Switch: 120/277-Volt, 20A, with ground, Hubbell HBL1221.
2. Three-way Switch: 120/277-Volt, 20A, with ground, Hubbell HBL1223.
3. Momentary Contact Switch: 120/277-Volt, 15A, with ground, Hubbell HBL1556.

2.03 RECEPTACLES:

A. All receptacles shall be from the same manufacturer and have identical physical appearance and characteristics.

B. Convenience receptacles for building services shall be grounding type, rated as specified and NEMA performance specification grade.

C. Convenience receptacle housings shall be heavy grade urea or ceramic, ivory color.

D. The following standard receptacles or their equivalent shall be used as indicated on the drawings, complete with boxes, angle adapters and associated hardware:

1. Convenience (Duplex): 120V, 20A, 1Ø, 2-wire with ground, Hubbell HBL5362.
2. GFCI (Duplex): 120-Volt, 20A, 1Ø, 2-wire with ground, Hubbell GF5362.
3. Power Receptacle: 208Y/120-Volt, 30A, 3Ø, 4-pole, 5-wire with ground, Twistlock, Hubbell HBL45305 (30A). Utilize three (3) unit cast box (Crouse Hinds FD03) with stainless steel covers (Pass & Seymour 430/SS).
4. Welding: 480-Volt, 60A, 3Ø, 3-wire with ground: Crouse-Hinds AREA6424.
5. Welding with Disconnect Switch: 480-Volt, 60A, 3Ø, 3-wire with ground: Crouse-Hinds WSRD63542.

E. All covers for wiring devices housing receptacles shall be of the metallic type. Plastic covers are unacceptable.

F. Weatherproof outlet plates shall have spring loaded gasketed doors, with covers that maintain the NEMA 3R rating while in-use.

PART 3 INSTALLATION

3.01 Subcontractor shall provide all material, equipment, and accessories as required for the complete installation and operation of the wiring devices as shown on the drawings.

3.02 WIRING DEVICES

A. Positive and clockwise phase rotation applies to 208V, 3Ø, 5-wire (female) power receptacles and 480-Volt, 3Ø, 4-wire (female) welding receptacles in accordance Fermilab's Technical Appendix of FESHM Chapter 5042. Subcontractor shall request the appendix prior to termination of receptacles. Improperly wired or terminated receptacles shall be re-wired by the Subcontractor, at no cost to Fermilab.

B. All receptacles shall be grounded with a green grounding conductor routed to the main grounding system by means of a clamp or terminal screw intended for this purpose. The raceway system is not an acceptable ground conductor.

C. A separate neutral conductor shall be provided for each circuit routed from the panelboard.

D. Locations shown are approximate. Determine exact locations at site by reference to building drawings and in conjunction with work of other trades.

3.03 CIRCUIT IDENTIFICATION

A. All electrical equipment and material shall be tagged with a nameplate identifying its source panel, breaker, and voltage. Items to be tagged shall include, but not be limited to, panelboards, motor starters, disconnect switches, light switches, night light fixtures, emergency exit signs and exit lights.

B. Engraved plastic tape, 3/4 in. in size, shall be used for this purpose. Tape shall be firmly and permanently attached to the housing or enclosure above the receptacle. Red tape with white lettering shall be used for all AC voltages above 250-Volts and white tape with black lettering shall be used for all AC voltages below 250 volts. “120VAC, PP-PHP-NL-15D1-1-A1” is a typical tag for a 120-Volt receptacle fed from panelboard PP-PHP-NL-15D1-1-A1, Circuit or Breaker 11. “PP-PHP-NL-15D1-1-A1 120/208 VAC CKT 4” is a typical white tag for a 30, 5-wire receptacle fed from 120/208VAC panelboard PP-PHP-NL-15D1-1-A1, circuit breaker positions 2-4-6. All tags shall be visible from the front of the device.

END OF SECTION 16140

SECTION 16145 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Photoelectric switches.
2. Indoor occupancy sensors.

B. Related Requirements:

1. Division 16 Section "Wiring Devices" for manual light switches.
2. Division 16 Section “Lighting Controls.”

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer. This includes lighting control devices listed under Specification 16570.

PART 2 - PRODUCTS

2.01 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. LC&D
4. NSi Industries LLC; TORK Products.
5. Tyco Electronics; ALR Brand.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.02 INDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Microlite Lighting Control Systems
2. Novitas, Inc.
3. Sensor Switch, Inc.
4. Watt Stopper, (The)
5. Leviton
6. LC&D
7. Lithonia Lighting

B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated fro 20 –A ballast load at 120- and 277-V ac, for 13 –A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA and Class 2 power source as defined by the Chicago Electrical Code.

3. Light-Level Monitoring Range: 10 to 200 fc for lighting control of general interior spaces, 100 to 1000 fc for lighting control of interior spaces with large window areas, including atriums and corridors with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.03 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. LC & D
5. Leviton Mfg. Company Inc.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.
12. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.

8. All sensors shall be dual-technology type, unless noted otherwise by Engineer.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.04 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. LC&D
5. Leviton Mfg. Company Inc.
6. Lightolier Controls.
7. Lithonia Lighting; Acuity Lighting Group, Inc.
8. Lutron Electronics Co., Inc.
9. NSi Industries LLC; TORK Products.
10. RAB Lighting.
11. Sensor Switch, Inc.
12. Square D; a brand of Schneider Electric.
13. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
4. All sensors shall be dual-technology type, unless noted otherwise by Engineer.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Types: SP, dual circuit or SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: 277 V] [Dual voltage, 120 and 277 V; dual-technology type.
5. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
6. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.05 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

PART 3 - EXECUTION

3.01 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.02 WIRING INSTALLATION

A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.03 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For day-lighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.06 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Division 16 Section "Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 16145

SECTION 16410 - ENCLOSED DISCONNECT SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for enclosed disconnect switches and circuit breakers. Subcontractor shall furnish, install, terminate, test and place into operation enclosed disconnect switches and circuit breakers, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 16010 – General Electrical Requirements.

B. Section 16080 – Electrical Testing and Inspection.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications:

A. NEMA (National Electrical Manufacturers Association):

1. Standard KS1-1983 for Type HD.
2. Standard AB1-1996 for Molded Case Circuit Breakers.

B. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).

C. Underwriters Laboratories, Inc.:

1. Standard No. 98.

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12.

A. The following submittal documents shall be furnished prior to equipment installation:

1. Product data for disconnect switches, and enclosed circuit breakers

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict Conformance to the drawings and specifications shall be required.

PART 2 - PRODUCTS

2.01 SEPARATELY MOUNTED CIRCUIT BREAKERS

A. Furnish and install separately mounted circuit breakers for overcurrent protection of feeders and branch circuits where shown on drawings.

B. Circuit breakers shall be: Thermal-magnetic, molded case type, rated 600-Volts, with interrupting rating of 35,000 rms amperes symmetrical minimum at 480-Volts, or rated 240-Volts, with interrupting rating of 22,000 or 10,000 rms amperes symmetrical minimum at 208-Volts.

C. Individual circuit breakers shall be mounted in NEMA 1, general purpose surface enclosures as shown. Provide NEMA 4 for outdoor enclosures. Provide with provisions for locking.

D. Acceptable Circuit Breaker Manufacturers: Only after compliance with all provisions of this section, the following manufacturer will be considered. This is due to the fact that interchanging of existing breakers at Fermilab is required:

1. Square D

2.02 FUSIBLE OR NONFUSIBLE DISCONNECT SWITCHES

A. Description: NEMA KS 1, Type HD, heavy duty, quick-make, quick-break, with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Voltage and current ratings to match requirements of the drawings.

B. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses

C. Furnish a solid neutral for each switch being installed in a circuit which includes a neutral conductor. Furnish a grounding pad for connection of circuit ground wires. Neutral and ground connections shall be factory installed kits.

D. A view window shall be provided for fusible and non-fusible disconnect switches.

E. The disconnect switch shall be furnished with provisions for locking with a padlock in the open position. Enclosures for switches shall be NEMA 1, general purpose, NEMA 4 weatherproof, or special enclosure, as shown.

F. Provide mechanical lugs and power distribution connectors for number, size, and material of conductors as indicated on drawings.

G. Disconnect switches for motor circuits shall be motor horsepower rated.

H. Acceptable Switch Manufacturers: Only after compliance with all provisions of this section, the following manufacturer will be considered. This is consistent with Fermilab's replacement spare parts inventory:

1. Square D, Class 3110

2.03 ENCLOSURES: Unless otherwise noted on the Subcontract drawings, electrical enclosures shall be as follows:

A. For dry indoor locations: NEMA 1.

B. For outdoor locations: NEMA 3R.

C. For indoor or outdoor wet locations: NEMA 4.

D. For oil-tight / dust-tight locations: NEMA 12 or NEMA 13.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Disconnect switches used on 277/480 VAC or 120/208 VAC systems and shall be provided for the following equipment:

1. Motor branch circuits when a combination starter is not used to disconnect both motors and controllers from all ungrounded supply conductors.
2. Within sight of motors when installed outdoors or when combination starter or branch circuit protection does not have lock-open provision and is not in sight or more than 50 ft-0 in. away from motor.
3. Feeders for overhead cranes, at a readily accessible ground floor location with the enclosure painted yellow with black stripes for quick identification.
4. In sight and within close proximity to unit heaters or duct heaters, when they are not provided with built-in disconnects.
5. In sight and within close proximity to HVAC equipment when such equipment does not have factory installed disconnects.

B. Secure circuit breakers or switches to Unistrut P-1000 rack as shown.

C. All disconnects shall be supplied with appropriate mounting hardware and strut support. Mounting hardware shall be corrosion resistant.

D. Installation of disconnects, shall be in conformance with the manufacturers requirements and as detailed on the drawings.

E. Inspect all disconnects for proper operation, tight and secure connections, and correctness. Adjust as necessary to assure proper operation.

F. Nuts, bolts, and screws shall be tightened to manufacturer's requirements.

G. Provide weatherproof, abrasion resistant, legend plates, for all disconnects, indicating the motor or device being fed.

H. All disconnect enclosures shall be bonded to ground with a ground lug or screw and a ground conductor.

I. Provide legend plates for each device noting system voltage, respective power source designation and location of respective power source.

J. Mount enclosures at 4 ft - 6 in. above finished floor.

3.02 Subcontractor shall furnish and install two (2) lamocoid nameplates for each disconnect. Nameplates shall be 2-1/2 in. high, and a minimum of 9 in. wide. Engraved character line width shall be 1/16 in. Characters and lines shall be neatly spaced and centered. Nameplate shall be affixed to the front, exterior of disconnect enclosure with 3M #9500PC, double side adhesive tape.

A. Nameplate 1:

1. Disconnect identification nameplate shall identify the disconnect on the first line and the voltage available within the disconnect on the second line.
2. First line of nameplate lettering shall be 1 in. high characters and indicate disconnect designation. Second line of lettering shall be 1/2 in. high and indicate disconnect voltage. Nameplates shall be red with white lettering. For example:
DS-TSA-7
277/480-VOLTS AC

B. Nameplate 2:

Color coding nameplate shall identify the conductor coloring convention for each disconnect. Nameplate shall be affixed to the inside of the disconnect and centered, and near the bottom. Color of nameplate shall be black with white lettering. Nameplate lettering shall be 1/2 in. high characters. Two (2) different types of nameplates shall be provided according to the disconnect voltage listed below:

1. For 120/208 VAC disconnects:
120/208 VAC BRANCH CIRCUITS
ARE IDENTIFIED BY BRB COLOR CODING
BLACK----A PHASE BLUE------ C PHASE
RED--------B PHASE WHITE-----NEUTRAL

2. For 277/480 VAC disconnects:
277/480 VAC BRANCH CIRCUITS
ARE IDENTIFIED BY BOY COLOR CODING
BROWN----A PHASE YELLOW---C PHASE
ORANGE--B PHASE GRAY-------NEUTRAL

C. Nameplate engraving shall be subject to the review and approval of Fermilab.

END OF SECTION 16410

SECTION 16441 - SWITCHBOARDS

PART 1 – GENERAL

1.1 SCOPE OF WORK This Section prescribes the minimum requirements of one (1) 2000Amp 480 Volt Switchboard supplied by the FNAL in the arrangement described in these specifications.

A. The designation for the switchboard is “SWBD-Mu2e-B1”

B. Included in these specification are the following drawings:

1. Power Single Line Diagrams
2. Cabinet Arrangement Drawings
3. Conductor Size Standards

C. An existing one-cabinet switchboard arrangement housing the distribution breakers.

D. Short Circuit and Device Coordination Analysis for a complete installation per NEC in accordance with section 110.10.

1.2 QUALITY ASSURANCE AND CONTROL:

A. Subcontractor shall be responsible for quality control and construction inspection.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and sections shall be required.

C. Switchboard will be furnished by Fermilab and installed by an Electrical Subcontractor. Refer to Exhibit A, Section 3.6.

1.3 SUBMITTALS:

A. Provide general arrangement drawings showing cabinet dimensions, circuit breaker layout and wire entry.

B. Submittal of Short Circuit, Device Coordination Analysis. Schedule of performance will be considered as part of the selection criteria.

C. Provide the product cut sheets for the circuit breakers, trip curves for each product and power monitoring system.

D. Complete description of installation requirements including required testing and start up procedures.

1.4 APPLICABLE STANDARDS: The publications listed below form part of this Section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the

Work included under this Section shall conform to the provisions of these publications:

A. ANSI (American National Standards Institute)

B. Federal Publications:

1. WP-115A
2. W-C-375a

C. NFPA (National Fire Protection Association) NEC (National Electric Code

D. NEMA (National Electrical Manufacturers Association)

E. NEMA PB-2

F. UL -891 (Underwriters' Laboratories, Inc.)

1.5 TECHNICAL SUBMITTALS:

A. None required.

PART 2 – PRODUCTS

2.1 CONSTRUCTION:

A. Existing Switchboard is NEMA 1, free standing, indoor type construction having approximate dimensions as shown on the drawing and to accommodate branch incoming line equipment and outgoing circuits.

B. A directory frame and card with protective covering shall be provided with each branch breaker.

2.2 RATINGS: Existing Switchboard is rated as follows:

A.	Voltage:	480/277 Volts
B.	Current:	2,000 Amperes
C.	Frequency:	60 Hz
D.	Service:	3Ø, 4 Wire
E.	Neutral:	Full capacity
F.	Ground Bus:	Full width
G.	Bus Bar Structure:	Braced to withstand 65,000 RMS (sym) amperes
H.	Incoming Lines:	Bottom Entry
I.	Outgoing Lines:	Top or Bottom Exit

J. Incoming Feeders: 5-600 MCM per phase
Incoming Neutral: 5-500 MCM cables
Incoming Ground: 5-250 MCM cables

2.3 CIRCUIT BREAKERS:

A. Circuit breakers shown in the switchboard are existing except circuit breakers for surge protective device and power monitor.

B. Subcontractor shall furnish and install one 15 amp, 3P, 480V, 65 kAIC circuit breaker for power monitor and one 60 amp, 3P, 480V, 65 kAIC circuit breaker for surge protective device as shown on single line diagram.

2.4 METERING: Subcontractor shall furnish an external mounted power monitoring system with an LED display.

A. Power monitoring system shall be Square D Powerlogic #PM820RD with Ethernet Card in an enclosure. The system shall be fully compatible with Fermi lab's existing Power logic SCADA system. See single line diagram for more details.

B. Provide all software, drivers, hardware, and programming to integrate the provided meter into the Fermilab Power Logic System. Setup shall be demonstrated and provided that results in a complete working system.

C. Power monitoring shall include three (3) phase current transformers with ratings of 2000:5A and shorting terminal strip. Current transformers shall be completely wired to the shorting terminal block.

D. Power monitoring shall include one (1) neutral current transformer with a rating of 2000:5A and shorting terminal strip. Currents transformer shall be completely wired to the shorting terminal block.

E. Power monitoring shall be shipped with all current transformer shorting terminal blocks in the grounded position.

F. Power monitoring shall be provided with a 600V rated fuse block and fuses completely wired for suitable for 480V power monitor inputs.

G. Power Monitoring System shall include the States Model#: 210-IW meter test switch. Provide additional test switches for all other metering devices.

H. The power monitoring system shall include an externally operated circuit breaker or disconnect switch that is capable of de-energizing all parts in the metering compartment without interruption in service to the switchboard bus. The purpose of this switch or breaker is to allow maintenance of the metering equipment without any exposure to energized parts.

I. The meter display shall be mounted at approximately 5'-0" above the finished grade.

2.5 SURGE PROTECTIVE DEVICE (TVSS):

A. Provide a surge protective device rated at 240 kA/phase minimum.

B. TVSS shall count and indicate the number of events.

C. The unit shall be mounted external with the switchboard with circuit breaker or disconnect switches such that all power to the unit can be locked and tagged out for full maintenance while the switchboard is energized in service.

2.8 ACCEPTABLE MANUFACTURERS:

A. Field verify of existing switchboard and provide breakers, power monitoring, surge protective device including other accessories from the same manufacturer.:

This is due to the fact that interchanging of existing breakers at Fermilab is required.

B. Listed below are acceptable component ratings (due to inter-changeability requirements):

C. Switchboard Designation: SWBD-Mu2e-B1

: Voltage 480/277V

PART 3 – EXECUTION

3.1 Subcontractor shall provide all material, equipment, software and accessories associated with the switchboard as required for the complete installation, testing and operation of the switchboard as specified.

A. Switchboard inspection and testing shall include the following:

1. Visual and mechanical inspection verifies that equipment is in compliance with specifications, Fermilab standards, and design intent and that no damage occurred during shipment.
2. The set up for devices, such as meters, current transformer, relays and timers, ensuring that all components are functioning correctly.
3. Electrical testing confirms that equipment meets optimum performance standards and provides test data documentation to use as a benchmark for future testing. Electrical tests shall include Insulation, Current Path, Functional System and Sequence.

3.2 Switchboards shall be solidly grounded with flexible cable to the grounding system.

3.3 No critter entry holes openings shall remain unplugged or exposed.

3.4 Subcontractor shall furnish and install one (1) lamocoid nameplates with beveled.edges for each switchboard. Nameplates shall be 2½” high, and a minimum of 9” wide. (The overall dimensions may be reduced for cases where the equipment cannot

accommodate the standard size.) Characters and lines shall be neatly spaced and centered.

A. The nameplate generally have two (2) lines of text. The first line would be the switchboard name (e.g. SWBD-Mu2e-B1). The second line would describe the operating voltages (e.g. 480Y/277 VAC).

B. First line characters are to be 0.85”-1” high with 1/8“ line width. Second line characters are to be ½“ high with 1/16” line width.

C. RED labels with WHITE characters shall be used for equipment operating at 480Y/277 VAC or 480 VAC or higher. When such equipment is capable of being powered by a dedicated Emergency or Standby power source, the equipment label shall be ORANGE in color with BLACK characters.

D. Equipment labels are preferably attached with a high quality, double-sided adhesive tape rather than screws. For indoor applications to smooth surfaces, 3M tape 9500PC is a preferred choice. For outdoor or rougher surface applications, Normount tape V2830 is a preferred choice.

3.5 Subcontractor shall furnish and install adhesive backed numbers adjacent to each circuit breaker for the purpose of numbering of the circuit breaker. Circuit breaker numbering shall be as per the Subcontract drawings.

A. Left side circuit breakers shall generally be numbered with odd numbers as 1, 3, 5, etc. (top to bottom).

B. Right side circuit breakers shall generally be numbered with even numbers as 2, 4, 6, etc. (top to bottom).

3.6 Packing and Delivery

All equipment shall be suitably packaged for short term cold storage. Packaging shall include protection during shipping and storage periods. Provisions shall be included for standard pallet moving equipment. Heating devices provided for storage shall be removed by manufacture at start up.

Shipping shall be configured such that a standard fork lift can readily off load all items without reconfiguration on the truck.

3.8 Testing and Startup

Subcontractor shall check existing switchboard section for completely assembled, wired and tested. Testing shall be performed per specification section 16080 – Electrical Testing and Inspection.

END OF SECTION 16442

SECTION 16442 – PANELBOARDS

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for Panelboards. Subcontractor shall furnish, install, terminate, test and place into operation all panelboards, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate Work prescribed by this section with work prescribed by these sections.

A. Section 16010 – General Electrical Requirements.

B. Section 16080 – Electrical Testing and Inspection.

1.03 APPLICABLE STANDARDS: The organizations listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these organizations:

A. NEMA (National Electrical Manufacturers Association).

B. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).

C. UL (Underwriters' Laboratories, Inc.):

1. Publication UL50.
2. Publication UL67.

D. Federal Specification WP-115B.

E. Federal Specification WCP-375B.

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12 and the following.

A. Front and side elevation drawings with dimensions.

B. Conduit entrance locations.

C. Circuit breaker characteristics, ratings and types (including short circuit interrupting ratings).

D. Installation and maintenance instructions.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 GENERAL

A. Panelboards shall be provided as specified herein, and as shown on the drawings.

B. Panelboards shall be classified as listed below:

TYPE	DESIGNATION	AMPACITY	VOLTAGE
Switchboard	SWBD	>1600A	277/480VAC
Distribution – High Power	DHP	600-1,600A	277/480VAC
High Power Panel	PHP	100-400A	277/480VAC
Lighting Panel	LP	100-225A	277/480VAC
Lighting Panel, Emergency	ELP	100-225A	277/480VAC
Power Panel	PP	100-225A	120/208VAC
Emergency Panel	E (Prefix)	Various	Various

2.02 CONSTRUCTION

A. Panelboards provided shall be NEMA rated with bus bars and circuit breakers properly supported to prevent vibration, breakage in handling and to withstand the effects of the indicated short circuit current:

1. Panelboards shall be NEMA 1, rated general purpose enclosures with reinforced, galvanized sheet steel frames.

B. Panelboards shall not exceed 78 in. in height and shall be constructed such that the height of the top operation of the panel does not exceed 6 ft - 6 in. from the floor. For those panelboards specified with integral current transformers, the height dimensions may be increased by 12 in.

C. Branch breaker types are as noted on the drawings and frames types may be oversized to provide cable lugs to accommodate increased conductor sizes due to voltage drop considerations.

D. Ample conductor and termination space shall be provided in the panelboard in accordance with the National Electrical Code.

E. Minimum width of NQOD panelboards shall be 20 in.

F. Enclosures shall be painted on all interior and exterior surfaces with rust inhibiting, prime coat. Finish paint shall be medium dark gray.

G. All panelboards shall be provided with hinged trim covers and door-in-door construction. Hinges shall be right hand (RH), unless noted otherwise on the drawings and shall allow for one person opening capability.

H. All panelboard doors shall be provided with flush catch mechanisms with stops at the top and bottom of the door. Mechanism shall not incorporate keyed door locks.

I. A directory frame and card with a protective covering shall be provided on the inside of each door. Loads from each breaker shall be neatly typed on the directory.

J. All nuts, bolts, screws, and washers shall be cadmium plated steel.

K. All terminals shall be solderless type suitable for copper or aluminum cables and sized for cables of the circuit breaker rating.

L. All spaces for future circuit breakers shall be equipped with bus, straps and necessary hardware for the insertion of the circuit breakers.

2.03 RATINGS: Panelboards shall be suitable for use on a 277/480 VAC, or 120/208 VAC, 3Ø, 60 Hz electrical system, as shown on the drawings.

A. All 120/208 VAC panelboards shall be provided with a 200 percent rated neutral bus.

2.04 BUSSING

A. Bus bars shall be fully rated, copper, and sequenced phased.

B. A fully rated copper, neutral bus with terminals for each circuit shall be provided.

C. A copper ground bus shall be provided for each panelboard. There shall be no factory installed, neutral ground bus connection internal to the panelboards.

2.05 CIRCUIT BREAKERS

A. All circuit breakers shall be of the dual element type, with an inverse time, bi-metallic overload element and an electro-magnetic element, unless noted otherwise.

B. Circuit breakers installed in panelboards designated as LP or ELP and circuits breakers used for lighting circuits shall be rated for switching duty.

C. Circuit breakers shall be connected to the buses such that the breakers may be removed or installed without disturbing other breakers or the operation of the equipment.

D. Multi-pole circuit breakers shall have a common trip and single operating handle.

E. A permanent, mechanical means, either factory or field installed, shall be provided for and attached to every circuit breaker to facilitate pad-locking of the circuit breaker operating handle in the “OFF” position. No additional hardware shall be required to effect pad-locking of the circuit breaker.

F. Panelboards shall be supplied with two (2) sets of adhesive backed numbers for circuit breaker numbering by the Subcontractor in the field.

2.06 SHUNT TRIP: When indicated on the drawings/panelboard schedule, panelboards shall be furnished with an integral shunt trip breakers.

2.07 ACCEPTABLE MANUFACTURERS

A. Only after compliance with all provisions of this Section, the following manufacturer of panels and breakers will be considered. This is due to the fact that interchanging of existing breakers at Fermilab is required.

B. All panelboards shall be furnished by the same manufacturer, utilizing standard interchangeable components.

C. All circuit breaker interrupting ratings shall be the UL ratings, at the particular voltage the breaker is to be applied.

D. Listed below are acceptable manufacturers and component ratings (due to inter-changeability requirements).

Panel Designation:	DHP PHP LP ELP
Voltage:	277/480 VAC
Minimum bus bracing (RMS amps):	50,000
Minimum integrated equipment short circuit rating (RMS amps sym)	35,000
Square D Company Type	I-Line

Type “NF” panelboards shall not be considered acceptable panelboard types.

Panel Designation:	PP
Voltage:	120/208 VAC
Minimum bus bracing (RMS amps):	25,000
Minimum integrated equipment short circuit rating (RMS amps sym)	10,000
Square D Company Type	NQOD

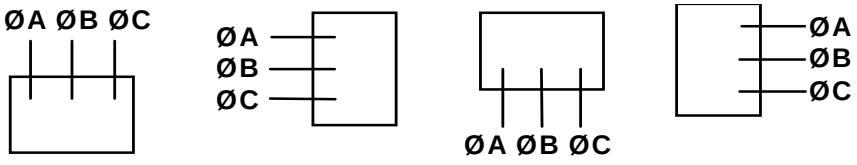
PART 3 EXECUTION

3.01 Subcontractor shall provide all material, equipment, and accessories as required for the complete installation, testing and operation of the panelboard systems as shown on the drawings.

3.02 Panelboard inspection and testing shall be in accordance with Section 16080: Electrical Testing and Inspection.

3.03 Generally, phase rotation sequence shall be A-B-C, left-to-right, from top-to-bottom, front-to-back or in a clockwise fashion as viewed from the front of the panelboard. Due to the inherent unique design of Square-D I-Line panelboards, entry to these panels and their associated circuit breakers is an exception to the standard form of entry and is separately detailed below:

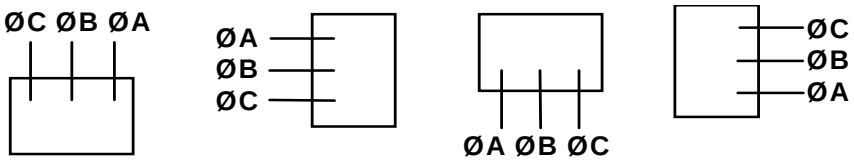
Standard Entry for Most Equipment (Other than Square D):



Top Entry Left Entry Bottom Entry Right Entry

Due to the inherent unique design of Square-D I-Line panelboards, entry to these panels and their associated circuit breakers is an exception to the standard form of entry and is separately detailed below:

Standard Entry for Square-D I-Line Panels



Top Entry Left Entry Bottom Entry Right Entry

3.04 All panelboards shall be solidly grounded with flexible cable to the grounding system. Ground conductor shall be bare, stranded copper and sized based on panelboard size as follows.

100A, 225A:	#2 AWG.
400A, 600A:	#2/0 AWG.
800A, 1200A:	#4/0 AWG.

3.05 Animal and rodent entry holes or openings shall be plugged or covered.

3.06 Subcontractor shall furnish and install two (2) lamocoid nameplates for each panelboard. Nameplates shall be 2-1/2 in. high, and a minimum of 9 in.-wide. Engraved character line width shall be 1/16 in. Characters and lines shall be neatly spaced and centered. Nameplates shall be affixed with 3M #9500PC, double side, adhesive tape.

A. Nameplate 1: Panel identification nameplate shall identify the panelboard name on the first line and the voltages available within the panelboard on the second line. Nameplate shall be affixed to the front, exterior of panelboard and centered above the panelboard door.

First line of nameplate lettering shall be 1 in. high characters and indicate panelboard designation. Second line of lettering shall be 1/2 in. high and indicate panelboard voltages. For example:

PHP-Mu2e-A1-1
277/480-VOLTS AC

1. For 277/480 VAC panelboards, nameplates shall be red with white lettering.

2. For 120/208 VAC panelboards, nameplates shall be black with white lettering.

3. For 277/480 VAC emergency panelboards, nameplates shall be orange with black lettering.

4. For 120/208 VAC emergency panelboards, nameplates shall be yellow with black lettering

B. Nameplate 2: Color coding nameplate shall identify the conductor coloring convention for each panelboard. Nameplate shall be affixed to the inside of the panelboard door or mat, centered and near the bottom. Color of nameplate shall be black with white lettering. Nameplate lettering shall be 1/2 in. high characters. Two (2) different types of nameplates shall be provided according to the panelboard voltages listed below.

1. For 120/208 VAC panelboards:

120/208 VAC BRANCH CIRCUITS
ARE IDENTIFIED BY BRB COLOR CODING

BLACK----A PHASE BLUE------ C PHASE
RED--------B PHASE WHITE-----NEUTRAL

2. For 277/480 VAC panelboards:

277/480 VAC BRANCH CIRCUITS
ARE IDENTIFIED BY BOY COLOR CODING

BROWN----A PHASE YELLOW---C PHASE
ORANGE--B PHASE GRAY-------NEUTRAL

C. Nameplate engraving shall be subject to the review and approval of Fermilab.

3.07 Subcontractor shall install two (2) sets of adhesive backed numbers adjacent to each circuit breaker internal to the panel for the purpose of numbering of the circuit breaker positions.

A. The first set of numbers shall be applied to the panelboard front mat adjacent to each circuit breaker pole position. The second set of numbers shall be installed interior to the panelboard in direct correspondence to the mat numbers. Three (3) pole breakers need only be labeled in the center position only:

1. Exact placement of the numbers shall facilitate identification and location of specific circuit breakers when the front mat is removed.
2. Circuit breaker position number shall not be applied to the physical circuit breaker.

B. Circuit breaker numbering shall be as per the Subcontract drawings and shall be subject to the review and approval of the Fermilab Construction Coordinator:

1. Left side circuit breakers shall generally be numbered with odd numbers as 1, 3, 5, etc. (top to bottom).
2. Right side circuit breakers shall generally be numbered with even numbers as 2, 4, 6, etc. (top to bottom).

END OF SECTION 16442

SECTION 16460 - DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for Dry-Type Transformers. Subcontractor shall furnish, install, terminate, test and place into operation all dry type transformers, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections.

A. Section 16010 – General Electrical Requirements.

B. Section 16080 – Electrical Testing and Inspection.

C. Section 16073 – Hangers and Supports for Electrical Systems.

1.03 APPLICABLE STANDARDS: The publications listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these publications.

A. ANSI (American National Standards Institute).

B. IEEE (Institute of Electrical and Electronics Engineers).

C. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).

D. NEMA (National Electrical Manufacturers Association).

E. UL (Underwriter’s Laboratory).

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12 and the following.

A. Physical dimensions and weights.

B. Connection diagrams.

C. Certified test reports.

D. Certificate of NEMA compliance.

E. Statement of Section compliance.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 GENERAL

A. Transformers shall be 3Ø, two winding type, delta-wye connected with an electrostatic shield.

B. The transformer primary shall be rated at 480V, 60 Hz, with two (2) 2-1/2 percent full capacity taps above and below rated voltage.

C. Transformer secondary shall be rated 208Y/120-Volt, 3-phase, 4-wire, or 480Y/277-Volt, 3-phase, 4-wire, with the neutral brought to a lug and bolt inside the case. The bolt shall extend outside the case such the neutral can be externally grounded.

D. When specified on the Subcontract drawings, “K” rated transformers shall be provided for neutral harmonic heat dissipation (K-13 minimum).

2.02 INSULATION: Transformer shall have a Class H insulation with an average temperature rise not to exceed 115°C temperature rise based on a 40°C ambient with 100 percent of the rated nameplate load connected to the secondary. Insulation used throughout shall conform to the applicable IEEE, ANSI and NEMA standards.

2.03 COILS

A. All coils shall be copper and continuous wire wound construction, vacuum impregnated with non-hydroscopic thermosetting varnish. Each layer shall have end fillers or tie downs to provide maximum mechanical strength.

B. Tag termination shall be brazed to the magnet wire.

C. Primary and secondary magnet wire to be brazed directly to bus stubs or lugs firmly mounted.

2.04 MAGNETIC CIRCUIT

A. All cores shall be manufactured from high grade, non-aging, 29 gauge silicone steel with high magnetic permeabilities, low hysteresis and eddy current losses.

B. Magnetic flux densities shall be kept below saturation to allow for a minimum 10 percent over voltage.

C. All laminations shall be cut with the direction of the grain and be free from burrs, and shall be core plated and stacked without gaps.

D. Cores shall be clamped with structural steel angles and bolted to the enclosure to prevent damage during shipment or rough handling and isolated by means of rubber vibration absorbing mounts.

E. Transformers shall be provided with quality, full-width electrostatic shields resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits:

1. Common Mode: 0 to 1.5kHZ – 120dB; 1.5kHZ to 10kHZ – 90dB; 10kHZ to 100kHZ-65B; 100kHZ to 1MHZ – 40dB.
2. Transverse Mode: 1.5kHZ to 10kHZ – 52dB; 10kHZ to 100kHZ – 30dB; 100kHZ to 1MHZ – 30dB.

2.05 ENCLOSURE

A. Lifting brackets shall be provided for all transformers, regardless of size.

B. Ventilated openings shall be provided in such a manner that accidental access to live parts is prevented.

C. The entire enclosure shall be degreased, cleaned, phosphatized with one (1) coat of zinc chromate and two (2) coats of gray baked enamel.

2.06 GENERAL CONSTRUCTION

A. All transformers shall have the core and coil mounted on a vibration mounting pad designed to suppress transmission of 120 cycle frequencies and harmonics thereof. Pads shall be arranged and selected on consideration of core and coil weights.

B. The core and coil shall be grounded to the frame of the transformer cubicle by means of a flexible grounding strap of appropriate size.

C. Maximum case temperature shall not exceed 35°C.

D. Transformers of all sizes shall be capable of being field modified for floor, wall or ceiling mounting.

2.07 SOUND LEVELS: Sound levels shall not exceed 47dB for 75kVA & 47dB for 112.5kVA transformer, and shall be substantiated by certified test reports.

2.08 ACCEPTABLE MANUFACTURERS

A. Only after compliance with all provisions of this section, dry-type transformers shall be manufactured by Square D. This is due to the fact that replacement of transformers may be required:

1. Dry type transformers shall be as follows:

30kVA:	Cat No:	EE30T3HFISCUNLP.
45kVA	Cat No:	EE45T3HFISCUNLP.
75kVA:	Cat No:	EE75T3HFISCUNLP.
112.5kVA	Cat No:	EE112T3HFISCUNLP

PART 3 EXECUTION

3.01 Transformer testing and inspection shall be in accordance with Section 16080: Electrical Testing and Inspection.

3.02 Final location of transformers shall be determined such that adequate ventilation is provided for the transformer. Transformers shall be installed in such a manner that normal clearance of passageways for personnel or equipment is not impaired.

3.03 Where transformers are indicated on the drawings as wall-mounted and are of such a size as to not normally be designed for wall mounting, Subcontractor shall provide the Fermilab Construction Coordinator with drawings (showing structure details, members, brackets, and supports of a platform) for a complete installation. Drawings shall indicate dimensions and weight of the specific transformer.

3.04 Floor-mounted transformers shall be installed on a 4” deep concrete housekeeping pad, in accordance with specification 16073. All pads shall have a minimum overlap of 4” on each side. Coordinate exact sizes with structural prior to pad or transformer installation.

3.05 Floor-mounted or wall-mounted transformers shall be installed with approved vibration eliminating mounting pads. A sample of the mounting pad shall be submitted to the Fermilab Construction Coordinator for approval prior to installation.

3.06 For 277/480 VAC and 120/208 VAC wye grounded systems, a solid ground connection shall be used. The neutral conductor shall be connected to this solid ground at the source (transformer) only. Solid grounding implies using exothermic (Cadweld) weld, ring-tongue lug or compression connector fitting attached to the bare, stranded copper ground conductor. Ring-tongue or compression ground connections shall be restricted to above ground or non-concealed locations only.

3.07 Final connection to transformers shall be flexible conductors in liquid flexible conduit for both primary and secondary connections. Sufficient loop shall be provided in the flexible conduit to dampen transmission of vibration of the transformer to the structure.

3.08 Transformer case, neutral and shield shall be solidly grounded with flexible cable to the grounding system. Ground conductor shall be bare, stranded copper and sized based on transformer size as follows.

A. Up to 75kVA: #2 AWG.

B. Greater than 75kVA: 4/0 AWG.

3.09 NO ANIMAL ENTRY HOLES OR OPENINGS SHALL REMAIN UNPLUGGED OR EXPOSED.

3.10 NAMEPLATES

A. Subcontractor shall furnish and a lamocoid nameplate for each transformer. Nameplate shall be 2-1/2 in. high, and a minimum of 9 in. wide. Engraved character line width shall be 1/16 in. Characters and lines shall be neatly spaced and centered.

B. Nameplate coloring shall be red with white lettering for all voltages in excess of 250-Volts and brown with white lettering for voltages 250-Volts and less.

C. Transformer identification nameplate shall identify the transformer name on the first line and the voltage available within the transformer on the second line. Nameplate shall be affixed to the front, exterior of transformer, centered, with 3M #9500PC, double side adhesive tape.

D. First line of nameplate lettering shall be 1 in.-high characters and indicate transformer designation. Second line of lettering shall be 1/2 in.-high and indicate transformer voltage. For example:

TR-PHP-TSA-5-
120/208-VOLTS AC

E. Nameplate engraving shall be subject to the review and approval of Fermilab.

END OF SECTION 16460

SECTION 16500 - LIGHTING SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK: This section includes the general requirements for Lighting Systems. Subcontractor shall furnish, install, terminate, test and place into operation all lighting systems, as specified herein and as shown on the subcontract drawings.

1.02 RELATED WORK: The following sections include items of related work. Coordinate work prescribed by this section with work prescribed by these sections.

A. Section 16010 – General Electrical Requirements.

B. Section 16080 – Electrical Testing and Inspection.

1.03 APPLICABLE STANDARDS: The organizations listed below form part of this section. Each publication shall be the latest revision and addendum in effect on the date of the subcontract award, unless noted otherwise. Except as specifically modified by the requirements specified herein or the details on the drawings, the work included under this section shall conform to the provisions of these organizations.

A. IEEE (Institute of Electrical and Electronics Engineers).

B. NEMA (National Electrical Manufacturers Association).

C. NFPA (National Fire Protection Association):

1. NFPA 70 (National Electrical Code).
2. NFPA 101 (Code for Safety to Life from Fire in Buildings and Structures).

D. UL (Underwriters' Laboratories, Inc.).

E. 10 CFR 435 (Code of Federal Regulations).

1.04 SUBMITTALS: Submittal documentation shall be in accordance with Exhibit A, Section 12, and the following.

A. Product data for light fixtures.

B. Physical dimensions and weights.

C. Connection diagrams.

D. Statement of Section compliance.

1.05 QUALITY ASSURANCE AND CONTROL

A. Subcontractor shall be responsible for quality control and construction inspection in accordance with Exhibit A.

B. All work is subject to the final acceptance by Fermilab. Strict conformance to the drawings and specifications shall be required.

PART 2 PRODUCTS

2.01 GENERAL

A. This section provides for all material, equipment, fixtures, lamps, standards and accessories required for the lighting installation as shown on the Subcontract drawings.

B. Fixtures shall be completely wired and constructed to comply with all local codes, the National Electrical Code and Underwriters' Laboratories inspection label.

2.02 CONSTRUCTION

A. All ferrous parts and supports of lighting fixtures, other than parts manufactured of stainless steel or aluminum, shall be completely rustproofed after fabrication and assembly and before finished coatings are applied. Rustproofing shall be by galvanizing, bondering, zinc plating, or by treatment by other approved rust proofing processes.

B. All screws, bolts, nuts, and other fastenings or latching hardware shall be cadmium plated, or of equivalent plating.

C. All metallic cast or extruded parts of lighting fixtures shall be closed grained, free from imperfections, rigid, true to pattern, properly fitted, filed, ground and buffed. Finished thickness of all cast parts shall not be less than 1/16 in.

D. All fixtures shall be provided with a final synthetic, high temperature, baked enamel coating of color and finish as specified or as noted. Unless otherwise specified, all exposed and reflective surfaces shall be enameled, oven baked at a temperature of 350°F. Reflectors shall have a minimum reflectance of 86 percent. Color of exposed surfaces shall receive proper etched surface preparation to assure adequate paint adherence and durability.

E. Where stainless steel or non-ferrous metal surfaces, other than reflectors, are to remain unpainted, or where steel surfaces are to be electro-plated, they shall be satin finished and coated with baked on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted and a permanent reflective surface with a minimum 85 percent reflectance is required:

1. All lenses shall utilize non-yellowing materials such as acrylic or borosilicate glass. All lenses, louvers or other diffusing elements contained in the fixture frames shall be removable, but positively held within the frame such that hinging or other motion of the frame will not cause the diffusing element to drop out.
2. HID fixtures shall be fitted with borosilicate glass and hinged lenses for UV attenuation and ease of maintenance.
3. Other lenses, louvers or other diffusing elements contained in the fixture frames shall be removable, but positively held within the frame such that hinging or other motion of the frame will not cause the diffusing element to drop out.

2.03 DISCHARGE LAMP FIXTURE CONSTRUCTION

A. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing the fixture from its mounting. Wireways shall have adequate access space for wiring, splicing of components mounted therein.

A. All elements of each fixture shall be held in place such that vibration and magnetic fields from ballasts cannot resonate or cause objectionable sound or sound levels.

B. Lamp holders:

1. Fluorescent lamp holders shall be located to insure contact at both ends of each lamp without the necessity of centering the lamp between the lamp holders. Lamp holders shall be rigidly mounted and reinforced to prevent change in dimension or misalignment, even under abnormally severe re-lamping stresses.
2. Lamp holders, except fluorescent types, shall be white porcelain, Mogul type, and shall be of the highest class and quality.
3. Lamp holders shall be provided with suitable arrangement to securely set and lock, by keyed slots or other positive means, the socket into the fixture to prevent slippage when screwing lamps in or out of the fixture.
4. Fluorescent lamp holders shall be white, as manufactured by General Electric, Hubbell, or equal.
5. Lamp holders shall be suitable for the specified lamps and set such that the lamps are positioned optically correct in relation to the lenses, baffles, reflectors, etc.

C. Fluorescent fixtures shall be provided with conduit knockouts on the sides and ends of the fixtures.

D. Ballasts:

1. Ballasts shall be suitable for the electrical characteristics of the supply circuits they are connected to and for the operation of the specified lamps.
2. Temperatures rise of the ballasts in fixtures shall not exceed 45°C upon testing.
3. Ballasts for fluorescent fixtures shall be rigidly mounted inside the fixture housing, with ballast surface and housing in complete contact for efficient conduction of ballast heat. Ballast mounting screws shall be permanently affixed to the fixture housing.
4. Ballasts shall be ETL certified and shall carry Certified Ballast Manufacturers and Underwriters' Laboratories labels.
5. Ballasts for fluorescent lamps shall be 120 VAC or 277 VAC operations, as required, and shall be one (1) lamp or two (2) lamp type only.
6. General Requirements for Electronic Ballasts:
   a. Comply with UL 935 and with ANSI C82.11.
   b. Designed for type and quantity of lamps served.
   c. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
   d. Sound Rating: Class A.
   e. Total Harmonic Distortion Rating: Less than 10 percent.
   f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   g. Operation Frequency: 42 kHz or higher.
   h. Lamp Current Crest Factor: 1.7 or less.
   i. BF: 0.88 or higher.
   j. Power Factor: 0.95 or higher.
   k. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
7. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
8. Electronic Programmed-Start Ballasts for T8, T5, and T5HO Lamps: Comply with ANSI C82.11 and the following:
   a. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
   b. Automatic lamp starting after lamp replacement.
9. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   a. Dimming Range: 100 to 5 percent of rated lamp lumens.
   b. Ballast Input Watts: Can be reduced to 20 percent of normal.
   c. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
   d. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
10. Fluorescent fixtures in non-radiation environments (above grade) shall be supplied with Class "P" Advance electronic ballasts. Ballasts

shall be specifically designed for the lamps specified. Unless noted otherwise, all electronic ballasts shall be as follows:

a. Advance Centium Ballasts.

11. Incandescent light fixture with incandescent lamp shall be provided in Radiation environments as noted on the lighting fixture schedule and as shown on drawings.
12. Ballasts for HID (high intensity discharge) lighting shall have a power factor of 90 percent or higher and shall operate at not higher than 120 percent of rated current and shall operate lamps at not less than 92-1/2 percent of rated wattage at rated voltage.
13. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
    a. Ballast Circuit: Pulse-start type.
    b. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
    c. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
    d. Lamp end-of-life detection and shutdown circuit.
    e. Sound Rating: Class A.
    f. Total Harmonic Distortion Rating: Less than 20 percent.
    g. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
    h. Lamp Current Crest Factor: 1.5 or less.
    i. Power Factor: 0.90 or higher.
    j. Interference: Comply with 47 CFR 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
    k. Protection: Class P thermal cutout.
    l. Ballast and lamp system shall comply with EISA 2007.
14. CWA ballasts with individual fuse protection shall be provided.

E. All fixture catalog numbers as shown on the Subcontract drawings are modified by these Sections, and it is understood that any fixture will be rejected unless it meets all the requirements specified herein, even if the fixture corresponds to the manufacturer and catalog number as shown on the drawings.

F. Lamp color shall be cool white, unless otherwise noted on the drawings. Lamps shall be color-corrected.

2.04 EXTERIOR LUMINAIRES, GENERAL REQUIREMENTS

A. Provide fixtures designed and manufactured specifically for outdoor service. Make components, including nuts, bolts, rivets, springs, and similar parts of corrosion resistant materials or of materials which will assure such resistance.

B. Provide wet location labeled outdoor fixtures for areas directly exposed to the elements. Fixtures which are aimed up shall be approved for wet locations in this position.

C. Paint metal parts of fixtures with suitable weather and moisture-resisting paint equal to epoxy-based coatings.

D. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations where required by UL.

E. Comply with IESNA for parameters of lateral light distribution patterns indicated for luminaires.

F. Metal Parts: Free of burrs and sharp corners and edges.

G. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

H. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

I. Doors, Frames, and Other Internal Access: Smooth operating, free of leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removed for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

J. Exposed Hardware Material: Stainless steel.

K. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

L. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

M. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 50 percent..

N. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

O. Luminaire Finish: Manufacturer’s standard paint applied to factory-assembled and tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.05 EMERGENCY LIGHTING

A. Emergency lighting shall be completely self-contained and shall provide emergency lighting for a minimum of ninety (90) minutes upon loss of normal electric lighting power.

B. Emergency power source shall be a 12-Volt rechargeable, maintenance free battery.

C. Electronics shall consist of an SCR solid state charger, transfer circuit, test switch and charge rate indicator.

D. SCR shall maintain the battery at full charge.

E. During emergency operation, damage from deep discharge shall be prevented by means of a low voltage automatic disconnecting circuit.

F. Upon restoration of normal power, the charger shall begin a recharge cycle to restore the battery to the fully charged state within the time limit as prescribed by UL.

G. Charger printed circuit board shall be environmentally coated to provide moisture corrosion, mold and fungus resistance.

H. Re-transfer time delay for activation of HID fixtures.

I. Unit shall be rated 277 VAC, 60 HZ.

J. Controls shall include the following:

1. A test switch to verify transfer operation.
2. A pilot light assembly indicating charge rate.

K. Swivel mounted lamps shall be two (2) 12W, glare free, halogen type side mounted.

L. Unless noted otherwise, all emergency lighting shall be as manufactured by Lithonia, Cat. No. IND1254-H1212-SEL.

M. Emergency lighting shall powered from the night light circuit serving the emergency light location.

N. In the Radiation environment area there shall not have any battery pack or any electronic device in the emergency lighting unit .

2.06 EXIT SIGNS

A. Exit Signs:

1. Exit signs shall be LED type, shall meet the requirements of UL 924 for face illumination and contrast ratio and shall meet or exceed the requirements of NFPA 101.

2. Exit signs shall be rated 277 VAC, 60 HZ.
3. LED’s shall be surge and transient protected.
4. LED average useful life to meet or exceed twenty (20) years under normal operating conditions. Exit signs shall be completely self-

contained and shall operate for a minimum of ninety (90) minutes upon loss of normal electric power.

5. Emergency power source shall be maintenance free high temperature nickel-cadmium battery.
6. A solid state battery charger shall maintain the battery at full charge.
7. Upon restoration of normal power, the charger shall begin a recharge cycle to restore the battery to the fully charged state within the time limit as prescribed by UL.
8. Charger printed circuit board shall be environmentally coated to provide moisture corrosion, mold and fungus resistance.
9. Controls shall include the following:
   a. A test switch to verify transfer operation.
   b. self diagnostic emergency sign and automatically test the battery
   c. A pilot light assembly indicating charge rate.
10. Emergency signs shall be factory wired to receive (optional) a fire alarm interface mode.
11. Emergency signs shall powered from the night light circuit serving the emergency light location.

12. In the Radiation environment area there shall not have any battery pack or any electronic device in the Exit sign. See lighting fixture schedule and drawings.

PART 3 EXECUTION

3.01 Subcontractor shall provide all material, equipment, controls, fixtures, luminaries, lamps, standards, and accessories as required for the complete installation and operation of the lighting system as shown on the drawings.

3.02 Subcontractor shall adjust locations of the fixtures specified to suit the following conditions.

A. When directed by the Fermilab Construction Coordinator.

B. To obtain symmetry between exposed beam drops, if minor revision only is required. To clear obstructions presented by work of other trades, if no other alternatives exist, and if approved by the Fermilab Construction Coordinator.

3.03 The mounting heights of all pendant type fixtures shall be shown on the drawings. Subcontractor shall verify all ceiling heights and clearances prior to fixture installation and submit a schedule for mounting heights to the Fermilab Construction Coordinator for all pendant type fixtures. Subcontractor shall provide all necessary hardware, Unistrut, clamps, threaded rods, hangers, nuts, bolts, etc. to mount the fixtures.

3.04 Any special work required to overcome unusual difficulties in fitting the fixture design to a particular location (such as to clear such unforeseen obstacles as ventilating ducts, piping, etc.,) or to increase the weight sustaining power of fixture

outlets, shall be done with the approval of the Fermilab Construction Coordinator, at no cost to Fermilab.

3.05 Fixtures shall be completely wired in an approved manner with #14 AWG (minimum) copper, stranded wire with 300-Volt, Type AF or SF-2, insulation silicone rubber insulation for recessed fixtures.

3.06 A separate neutral conductor shall be provided for each circuit installed from the panelboard.

3.07 Every lighting branch circuit shall have its own individual neutral conductor, labeled to correspond to the branch circuit breaker number feeding that particular circuit.

3.08 Each lighting fixture shall be tagged with a label identifying its source panel, breaker and voltage. Adhesive plastic tape, minimum 1/2 in. in width, shall be used. Tape shall be firmly and permanently attached to the fixture housing or enclosure. Red tape with white lettering shall be used for all AC voltages above 250 VAC. White tape with black lettering shall be used for all AC voltages below 250 VAC. “LP-MU2E-A1-2 277 VAC CKT 4” is a typical red tag for a fixture fed from a 277/480 VAC lighting panelboard LP-Mu2e-A1-2, circuit breaker position 4.

3.09 Lighting fixtures shall not be permitted to be used as part of the raceway system. Subcontractor shall furnish and install a junction box for each lighting fixture, located adjacent to or as close as possible to the fixture, for final connection to the fixture. This junction shall box shall be furnished and installed by the Subcontractor, even though the junction box may not be shown on the drawings.

3.10 There shall be no splicing of wiring other than those absolutely required. Fixture wiring shall be of sufficient length for making approved connections luminaire outlets, lamp holders, or ballasts. Splices shall be made with approved spring type insulated connectors.

3.11 After fixtures are connected to the distribution system, Subcontractor shall verify all wiring and fixtures are free from short circuits, grounds, and faulty wiring. Subcontractor shall supply all necessary apparatus to correct defects and arrange to have the complete system in perfect working order.

3.12 Fixtures shall be cleaned by the Subcontractor prior to acceptance of the system. Lamps used during the construction period shall be replaced with new lamps prior to acceptance of the system.

3.13 As soon as any portion of the lighting system is ready for operation, Fermilab shall have the right to operate the system. Operation of the system by Fermilab shall not imply acceptance of the system.

END OF SECTION 16500

SECTION 16570 - LIGHTING CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1.02 SUMMARY

1. This Section includes manually operated, PC-based, digital lighting controls with external signal source relays and control module.
2. Related Sections include the following:
   a. Division 16 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multipole contactors.

1.03 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. Low Voltage: As defined in CEC for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

F. PC: Personal computer; sometimes plural as "PCs."

G. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

H. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

1.04 SUBMITTALS

A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.

1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution

system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

D. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

E. Field quality-control test reports.

G. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

H. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

I. Warranty: Special warranty specified in this Section.

1.05 COMMISSIONING

A. Section 01810 “General Commissioning Requirements” requires the engagement of a Commissioning Agent to document the completion of the Plumbing, HVAC, and Electrical systems for the project. Comply with the requirements of Section 01810 as a Commissioning Team member for the commissioning of the various building systems.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer. This includes lighting control devices listed under Specification 16145.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

1.07 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of lighting control functions.
2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure of software input/output to execute switching or dimming commands.
   b. Failure of modular relays to operate under manual or software commands.
   c. Damage of electronic components due to transient voltage surges.
4. Warranty Period: Five (5) years from date of Substantial Completion.
5. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight (8) years.
6. Extended Warranty Period for Electrically Held Relays: Ten (10) years from date of Substantial Completion.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Electrically Held Relays: Equal to 10-percent of amount installed for each size indicated, but no fewer than two (2) relays of each type.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.

1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Leviton Mfg. Company Inc.
2. Lighting Control & Design, Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. TRIATEK, Inc.
5. Watt Stopper (The).

2.02 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 50 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

2.03 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Unit shall be programmable for control of indicated number of output circuits. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices, all located in other enclosures. An integral keypad shall

provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD shall display manual-control and programming steps. Modules and their associated control panels shall include the following features:

1. Multiple inputs and multichannel output arranged for 8 → 48 channels.

2. Multiple inputs for indicated occupancy sensors and hand-held programming device.

B. Control Module Description: Comply with UL 508 (CSA C22.2, No. 14); microprocessor-based, programmable, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.

2.04 POWER DISTRIBUTION COMPONENTS

A. ”LRP” Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.
   a. Barriers separate low-voltage and line-voltage components.
   b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
   c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
   a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
   b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
   c. Endurance: 50,000 cycles at rated capacity.
   d. Mounting: Provision for easy removal and installation in relay cabinet.
3. Each relay will have digital dimming control.

B. “LRSP” Modular Relay Satelite Panel: Same specification as “LRP” Panels, with the following differences:

1. Maximum of 8 relays.
2. Direct inputs for local switches, sensors, and other controls.

C. “LRSPD” Modular Relay Satelite Panel (Dimming): Same specification as “LRSP” panels with the following differences:

1. Each relay will have digital dimming control

D. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.05 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type, with up to 4 buttons per switch location.

1. Match color specified in Division 16 Section "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 16 Section "Wiring Devices."

C. Wall Plates: Single and multigang plates as specified in Division 16 Section "Wiring Devices."

D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.06 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 16 Section "Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 16 Section "Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 16 Section "Conductors and Cables."

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and manufacturer’s requirements.

PART 3 - EXECUTION

3.01 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways. Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 3/4 inch (13 mm).

C. Controls low voltage wiring shall be installed in separate conduits from power wiring. Exact control wiring requirements shall be coordinated with manufacturer of lighting control system.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

E. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

F. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

H. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by Architect.

3.03 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.04 ADJUSTING

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual

occupied conditions. Provide up to two (2) visits to Project during other than normal occupancy hours for this purpose.

3.05 DEMONSTRATION

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 16570

SECTION 16721

FIRE ALARM SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK:

A. The Subcontractor shall be responsible for all material, labor, logistical and technical resources, and coordination necessary for the complete execution of the work.

B. The work in this section includes, but is not necessarily limited to:

C. Installation of a new low voltage, addressable-type fire voice alarm system, including: spot-type smoke detection, manual pull stations and monitoring of sprinkler systems. The fire alarm system shall include: addressable fire alarm control panels, manual fire alarm stations, fire alarm speakers, visual alarm devices, spot-type smoke detectors, air sampling smoke detection, line type heat detection, conduit, electrical mounting backboxes, terminal cabinets, wiring raceways, pull boxes, outlet and mounting boxes, and all other accessory items required for a fully operational system even though each item is not specifically mentioned or described. Provide line type heat detection panel, terminating circuit at Experimental Hall for future expansion into beam enclosure.

D. Preparation of the specified submittals.

E. Provide a microprocessor, software driven, multiprocessor designed, user keypad, field programmable via laptop computer, one person walk test feature, and alarm verification housed in the main control board/panel.

F. Performance of acceptance testing of completed system, including documentation.

G. Provide all required relay outputs, conduit and wire required for the FIRUS (Fermilab Incident Reporting Utility System) connections, terminated in a terminal cabinet adjacent to the existing FIRUS panel, as indicated in the bid documents.

1.02 WORK BY OTHERS:

A. The following work associated with the work of this section is Not in Contract (N.I.C.) and will be provided by Fermilab. Termination of all connections between the new fire alarm system and FIRUS. Subcontractor shall provide all required relay outputs, conduit, and wire required for these connections, terminated in a terminal cabinet adjacent to the existing FIRUS panel.

1.03 RELATED WORK: The following sections prescribe items of related work. Coordinate work prescribed by this section with work prescribed by these sections:

A. Section 16010 Electrical - General Requirements

B. Section 16120 Low Voltage Wire and Cable – 600V

C. Section 16185 Mechanical Equipment Wiring

1.04 COORDINATION WITH OTHER TRADES

A. Coordinate all work under this section with all related work as applicable and as indicated elsewhere in the plans and specifications.

B. Failure to properly coordinate with related trades and related work shall be corrected as part of the work of this section at no extra cost to Fermilab.

1.05 PRODUCT LISTINGS & APPROVALS

A. All system components for which UL listing categories exist shall be listed by Underwriter's Laboratories Inc. (UL) and/or approved by Factory Mutual (FM) for the intended application.

1. All components shall be listed in the current edition of the UL Fire Protection Equipment Directory or the FM Approval Guide or both. Components shall be delivered to the project site with factory applied, UL and/or FM stickers. System components which do not meet these requirements are not acceptable.

2. Components for which UL listing or FM approval are "pending" are not acceptable.

B. All system components are subject to the approval of Fermilab with regard to their fitness for the intended application.

1.06 ACCEPTABLE EQUIPMENT MANUFACTURERS:

A. Equipment and components which comply with the requirements of these specifications as manufactured by any of the following are acceptable:

1. Siemens Fire Safety

1.07 APPLICABLE STANDARDS AND CRITERIA

A. The fire alarm system shall be installed in accordance with the following standards:

1. NFPA 13, Standard for the Installation of Sprinkler Systems, 2013.

2. NFPA 70, National Electrical Code, 2011.

3. NFPA 72, National Fire Alarm Code, 2013.

4. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating System, 2012.

B. In the event of differences between the requirements of the specified standards and these specifications, the more stringent requirement(s) shall apply.

1.08 TECHNICAL SUBMITTALS:

A. General Requirements - The requirements of this section supplement the general requirements for Submittals, Shop Drawings, Material Samples, and As-Built drawings included in Section 5.0 of Exhibit A.

1.09 SHOP DRAWINGS

A. Fire alarm system shop drawings shall include a complete equipment list, manufacturer's installation manuals/instructions for all devices and equipment, a drawing legend, plan view drawings, typical wiring diagrams, detailed wiring diagrams, and calculations as described herein.

B. The equipment list shall identify types, models (manufacturer's part numbers) and quantities of all major components, including copies of the corresponding manufacturer's catalog data sheets. When a catalog data sheet shows more than one product, the proposed product, and the specific information applicable to the proposed product, shall be clearly indicated by arrows or other suitable means. This submittal shall include, but not necessarily be limited to the following:

1. Conduit, raceway, junction boxes, terminal cabinets, device back boxes, fittings, hangers and mounting hardware.

2. Wire, cable, connectors, and terminal strips.

3. Fire alarm control equipment and annunciators, including all panels, components, modules and enclosures.

4. Manual fire alarm stations, detectors, auxiliary function relays, and evacuation signaling devices.

5. Standby batteries.

C. Manufacturer's installation manuals/instructions shall be the same as packaged with the equipment from the manufacturer. Photocopies are not acceptable.

D. The drawing legend sheet shall identify:

1. All symbols used on the drawings, by type of device or equipment, manufacturer and manufacturer's part number. This information shall be consistent with the manufacturer's catalog data sheets required as part of the equipment list.

2. All conventions, abbreviations and specialized terminology used on the drawings, as necessary to understand and interpret the information contained thereon.

3. All color codes and conduit, conductor/circuit and device numbering systems, as necessary to cross-reference between the shop drawings, the required testing documentation, and Operation & Maintenance Manuals.

4. A complete drawing list identifying all shop drawings by title and drawing number.

E. Plan view drawings shall be single line or architectural drawings, drawn to an indicated scale 1/4-inch scale or larger, showing:

1. Name of Project.

2. Location, including street address.

3. Point of compass.

4. Graphical scale indicator.

5. Exterior building dimensions (or extent of enclosed space for underground spaces).

6. Locations of all walls, partitions extending to within 18" of the ceiling, exits and anticipated fire department response points.

7. Use or occupancy of each room or area (i.e., office, mechanical room, storage, etc.).

8. Locations of all fire alarm system devices, equipment, risers and electrical power connections.

9. Locations and identification of all non-fire alarm system equipment monitored and/or controlled by the fire alarm system.

10. Point-to-point (actual) conduit, raceway and circuit routing, identifying number, size and type of conduits/raceways and conductors. This information shall be depicted in sufficient detail to readily locate specific conduits, raceways and circuits in the field and to identify the specific conductors/circuits contained therein. All penetrations of fire-rated barriers shall be individually noted.

11. A Conduit fill-in chart form, indicating the cross-section area percent fill for each type of wire/cable in each size of conduit used in the system.

F. Typical wiring diagrams shall be provided for all signal initiating and evacuation signaling devices, identifying all required terminations, including types of terminations (terminals or pigtails) and pigtail/terminal identifications. All unsupervised connections and terminations shall be noted "unsupervised."

G. Detailed wiring diagrams shall be provided for all alarm control panels, control panel modules, power supplies, electrical power connections, addressable monitor and control modules, and remote signaling equipment, identifying all required terminations, including terminal identifications. All unsupervised connections and terminations shall be noted "unsupervised."

1. These diagrams shall depict and identify all circuit boards, modules, power supplies, standby batteries, PROM's and EEPROM's, fuses, dip switches, jumpers, LED's, indicators, adjustable controls and components, ribbon connectors, edge connectors, wiring harnesses, terminal strips and connections thereto, including spare zones and circuits. Where multiple components of a similar type are provided, each shall be identified by a unique component number.

2. These diagrams shall include front-view details of all control panels and annunciators, depicting and identifying all indicators, controls and zone labels, including proposed nomenclature.

3. These diagrams shall depict the required information to relative scale, actual size or larger, showing proper spatial relationships between components, and shall reflect the corresponding system components as they are to be installed.

H. Calculations shall be provided for each power supply, battery charger, and configuration of standby batteries in the system, identifying both the non-alarm and alarm load associated with each, and demonstrating conformance to the requirements of these specifications relative to sizing/capacity.

I. The complete shop drawing submittal shall include any additional information necessary for installation of the system.

J. All drawings and diagrams shall be CAD generated using AutoCad. Marked up copies of catalog data sheets are not acceptable in lieu of the required drawings or diagrams.

K. All drawings and diagrams shall include the Subcontractor's title block, complete with drawing title, Subcontractor's name, address, date including revisions, and preparer's and reviewers initials.

L. Plan view drawings required for this submittal may be generated using the bid drawings as backgrounds. Copies of the AutoCad files used to generate the bid drawings will be made available to the Subcontractor at no cost.

1.10 MATERIAL SAMPLES

A. Engineering Department reserves the right to require samples of major system components prior to approval of shop drawings. These samples will only be required in the event that the shop drawing submittal does not provide sufficient information to evaluate the proposed equipment.

B. When required, Subcontractor shall provide material/component samples in original factory cartons with all factory documentation, including evidence of UL listing/FM approval.

C. Samples shall include some or all of the following, as directed by Fermilab:

1. Fire alarm control panels.

2. Automatic Detectors.

3. Manual fire alarm stations.

4. Evacuation signaling devices.

5. Addressable monitor and control modules.

6. Fault isolator modules.

7. Conduit and Raceway.

8. Wire and cable. Wire and cable samples shall be 24 inches in length, minimum, and shall be labeled to identify the type of wire or cable, manufacturer, manufacturer's part number, and a description of the intended use for that particular wire or cable.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Subcontractor shall submit at the completion of the project an Operation and Maintenance Manual, prepared specifically for this project and bound in an indexed 3-ring binder, containing:

1. A detailed narrative description of the system architecture, inputs, evacuation signaling, auxiliary functions, annunciation, intended sequence of operations, expansion capability, application considerations and limitations.

2. Operator instructions for basic system operations including procedures for alarm acknowledgment, system reset, interpreting system output (LED's and printout), operation of manual evacuation signaling and auxiliary function controls, changing printer paper, etc.

3. A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including a testing and maintenance schedule and detailed testing and maintenance instructions for each type of device installed.

4. Detailed troubleshooting instructions for each specific type of trouble condition recognized by the system, including opens, grounds, parity errors, "loop failures," etc. These instructions shall include a list of all trouble signals annunciated by the system, a description of the condition(s) which will cause those trouble signals, and step-by-step instructions describing how to isolate those problems and correct them (or call for service, as appropriate).

B. The detailed description of routine maintenance and testing shall include:

1. A listing of the individual system components which require periodic testing and maintenance.

2. Step-by-step instructions detailing the requisite testing and maintenance procedures and the intervals at which those procedures should be performed, for each type of device installed.

3. A schedule which correlates the step-by-step testing and maintenance procedures with the listing of individual components. This schedule shall be completed for the duration of the warranty period or for one complete testing/maintenance cycle, whichever is longer.

4. A list of recommended spare parts, including current unit prices (delivered costs), as necessary to maintain the system in operation on a continuous basis.

5. A service directory, including a list of individual's names and telephone numbers for whoever should be called to obtain service on the system, including normal warranty service and 24-hour emergency service.

C. The preliminary manual will be reviewed for required content and approved or disapproved on that basis. Upon completion of the project, the Subcontractor shall revise the approved, preliminary manual to be consistent with the system as installed and specifically to coordinate the testing and maintenance schedule with the approved Subcontractor testing protocols and with the fire alarm device numbers indicated on the Subcontractor's as-built drawings.

D. The revised manual shall constitute the basis for the on-site Training Sessions required elsewhere in this Section, and as such shall be both specific to this system, containing a minimum of superfluous information, and suitable for that purpose.

E. This manual shall be written, compiled and edited specifically for this project and the system installed. Unedited manufacturer's catalog data sheets and/or equipment manuals are unacceptable as content for this submittal.

1.12 TEST PROTOCOLS:

A. All system testing shall be conducted in accordance with approved test protocols prepared by the Subcontractor. Written test protocols including detailed test procedures, documentation forms and expected test results shall be submitted to Fermilab for approval prior to performing those tests and within 90 days of award of contract. The approved test protocols shall be included as a section in the Operation & Maintenance Manual submittal required elsewhere in these specifications.

1.13 AS-BUILT DRAWINGS

A. In addition to the requirements of Section 10.0 "As-Built Drawings" in Exhibit A, the Subcontractor shall provide one set of the AutoCad files for the shop drawings, updated to reflect all red-line markups on the construction "as-built" drawings set. These updated drawing files shall also include:

1. All junction boxes and terminal cabinets.

2. Locations of all electrical enclosures of any kind that contain one or more splices shall be noted "splice."

3. Addresses for all addressable components.

B. This submittal shall also include a complete printout of the system program. This printout shall be produced and dated upon completion of all required Subcontractor testing/verification.

1.14 GENERAL DESCRIPTION OF THE SYSTEM

A. The new fire alarm system shall be a 24 VDC, analog addressable system consisting of a fire alarm control panel, dedicated signaling line (addressable) and notification appliance circuits, and associated initiating devices and notification appliances, as indicated on the drawings

B. Provide notification appliance circuit auxiliary power (NAC) supply panels as needed for power to the visual/audible devices. NAC panels should be supervised by the main FACP and AC power shall be in accordance with Section 1.18 entitled POWER SUPPLIES.

C. All system wiring shall be installed in conduit.

D. The new fire alarm system shall provide a unique "address" for each addressable device in the system, including an associated, user programmable message identifying the type of device and its location.

E. The new fire alarm system shall be connected to Fermilab's existing FIRUS as specified herein.

1.15 CIRCUIT PERFORMANCE AND SUPERVISION

A. All wiring required for proper system operation, except as specifically allowed herein, shall be electrically supervised for opens, shorts between pairs (notification appliance circuits only), and shorts to ground. Wiring faults on supervised circuits shall initiate trouble conditions.

B. All multiplexed and addressable data circuits shall be "Class B" two-wire circuits, conforming to NFPA 72 definition of Pathway Survivability level 1 circuits.

C. All evacuation signaling circuits shall be "Class B" two-wire circuits, each for visual and speaker circuits, conforming to NFPA 72's definition of Pathway Survivability level 1 circuits.

D. Any single open or single ground condition on any non-addressable initiating device circuit or non-addressable auxiliary function circuit shall cause a trouble signal.

E. All AC power connections and standby battery connections shall be electrically supervised such that disconnection of any fire alarm system (primary or backup) power supply shall cause a trouble signal.

1.16 COMPONENT SUPERVISION

A. All control components shall be placement supervised such that removal of any control panel module shall cause a trouble signal.

B. All power supplies/battery chargers shall be supervised for loss of normal AC operating power. Loss of AC power to any power supply/battery charger shall cause a trouble signal.

C. All power supplies shall continuously monitor the presence of the batteries, battery voltage, and charging status, causing a trouble signal in response to a low battery, missing battery or charger failure condition.

D. The availability of operating power to the fire alarm system, including all required components thereof, shall be supervised to the point of connection to the dependent equipment. Loss of operating power to any required system component(s) shall cause a trouble signal. Trouble signals caused by loss of operating power shall be distinct from trouble signals caused by wiring faults in signaling line, initiating device, or notification appliance circuits.

E. All manual fire alarm stations, detectors, evacuation signaling devices and auxiliary function relays or other devices shall be supervised such that removal of any manual fire alarm station, detector, evacuation signaling device, auxiliary function relay or other device shall cause a trouble signal.

Removal and replacement of addressable smoke detectors for cleaning shall not cause a fire alarm signal. Systems which are incapable of providing immunity from false alarms caused by routine cleaning of detectors are not acceptable. Systems which require detectors or alarm functions to be disabled in software to avoid false alarms during cleaning are not acceptable.

F. Proper operation of addressable devices shall be automatically tested by the system via a continuous polling interrogation/response operation. Failure of one or more addressable devices shall cause a trouble signal.

1.17 POWER SUPPLIES

A. All fire alarm system AC power connections shall be hardwired via dedicated circuits serving no other load(s). Each AC circuit/switch shall be labeled and locked, see detail on drawings. All associated conductors and connections shall be installed entirely within approved electrical enclosures, conduits or raceway. Circuit breakers shall be clearly labeled "Fire Alarm System Power" and shall be locked (padlocks provided by Fermilab).

B. All portions of the fire alarm system, including LCD displays, shall be designed and equipped to be capable of operating on standby (rechargeable) battery power.

C. Speaker and Strobe light circuits shall be powered from dedicated power supplies serving no other loads. Design load for strobe light power supplies shall not exceed 66% of their (continuous) rated capacity. Battery size shall be calculated by determining required amp-hour capacity (load x time) and multiplying by 0.66.

D. Design load connected to all power supplies, except dedicated power supplies for speaker and strobe light circuits, and for all standby batteries and uninterruptible power supplies shall not exceed 80% of their (continuous) rated capacity. Battery size shall be calculated by determining required amp-hour capacity (load x time) and multiplying by 0.80.

E. Standby battery capacity shall be sufficient to maintain the entire system in a non-alarm condition for 24 hours, followed by 5 minutes in full load alarm condition (all fire alarm initiating devices in alarm, and all evacuation signals, annunciators and auxiliary functions activated simultaneously), on battery power only.

F. All power supplies, shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 24 hours maximum. Standby battery capacity may be upsized to meet this requirement.

G. All batteries shall be maintenance-free type. Wet-cell lead-acid standby batteries are prohibited.

H. Battery chargers shall be compatible with the batteries provided.

1.18 EMI/RF PROTECTION

A. All fire alarm control equipment, devices and wiring shall be protected as necessary to prevent electro-magnetic/radio frequency interference or induced voltages caused by AC power circuits, electrical transformers, motors or switchgear, electronic equipment, fluorescent lighting fixtures, hand held portable radios, cellular phones or other devices.

B. The system shall be designed and installed so as operate properly in the electromagnetic environment in which it is installed, and to be unaffected (with all control cabinet face plates installed) by the operation of hand held, portable radios of up to 5 watts, or portable cellular telephones of up to 1 watt, within 12 inches of any system component(s).

C. All circuits shall be segregated, shielded, and equipped with EMI filters as necessary to eliminate induced voltages and audio and/or electrical crosstalk between circuits. Where necessary, separate, isolated power supplies, shielded equipment cabinets, or other appropriate means of eliminating induced voltages and interference/crosstalk shall be provided.

D. The AC grounding and bonding system shall consist of bare copper cables for the grounding of all associated AC electrical equipment for the fire alarm installation, in accordance with NEC Article 250. The fire alarm (DC) grounding system shall be in accordance with NEC Article 760 and the manufacturer’s recommendation.

1.19 FIRUS INTERFACE AND SYSTEM OUTPUTS TO FIRUS

A. Each fire alarm system shall provide 3 SPDT relay outputs to FIRUS. All relay outputs for connection to FIRUS shall be listed or approved for use in off-premises signaling applications. Signals to be transmitted include:

1. Common Fire Alarm – Mu2e Building
2. Common Supervisory Alarm – Mu2e Building
3. Common Trouble – Mu2e Building

B. General alarms shall be interfaced from the outputs at the fire alarm control panel. The individual descriptive messages shall be via addressable relay modules.

C. FIRUS relay outputs shall be located in the fire alarm control panel.

D. Subcontractor shall provide a designated, conduit and wiring as needed between the fire alarm control panel and the FIRUS panel. Relay outputs shall be permanently labeled in the fire alarm control panel with engraved plastic placards; "FIRUS- FIRE ALARM","FIRUS-COMMON SUPERVISORY", and "FIRUS-COMMON TROUBLE", respectively.

1.20 TERMINATIONS BY FERMILAB

A. All terminations to FIRUS will be made by Fermilab.

B. Testing of the FIRUS connection to verify proper outputs from the fire alarm system is part of this subcontract.

PART 2 PRODUCTS

2.01 FIRE ALARM CONTROL PANEL

A. Fire alarm control panels shall be of modular construction to facilitate system expansion and servicing, and operating voltage shall be 24 VDC, Siemens-Cerberus Fire-Finder XLS with Voice.

1. The network architecture shall be “Class A & B” two-wire circuits conforming to NFPA 72 definition.
2. The network architecture shall include distributed logic and processing of both inputs and outputs. In the event of disruption of network communications or failure of one or more individuals panels, the remaining portions of the network shall continue to operate, providing “degrade mode” operation consistent with normal, automatic operation, for their associated portion(s) of the overall system.
3. Networking requirements specified herein are for future expansion of the system. This capability shall be available, using listed components, in the equipment provided for this project. “Planned upgrades” of current equipment are not acceptable as satisfying these requirements.

B. Fire alarm control equipment shall be modular construction to facilitate system expansion and servicing, and shall be housed in locking metal or metal and glass enclosures. All manual controls shall be behind locked cabinet doors or key operated, or both. All locks shall be keyed "T-45" with key and lock assembly.

C. The time delay between activation of an alarm initiating device (excluding retarded waterflow switches and smoke detector circuits arranged for automatic alarm verification) and activation of the associated automatic evacuation signaling and automatic auxiliary control function shall not exceed 10 seconds.

D. Fire alarm control panel shall be capable of being programmed in the field using either an integral keypad or a laptop computer.

E. The fire alarm system control equipment shall be capable of supporting all addressable devices in alarm simultaneously, without impairing normal operation of the system.

F. Fire alarm control panel shall have an 80 character Liquid Crystal Display (LCD) with touch screen and LED display. At least 5 events shall be shown simultaneously with two full lines of text message for each event. In addition, the LCD shall also have the ability to display a detailed screen that provides the following:

1) 200 character custom message associated with the group of the device
2) NFPA symbols representing fire service equipment in the area
3) NFPA symbols representing hazards in the area
4) NFPA symbols representing people in the area
5) Number of devices in the associated group that are in alarm

G. The Live Voice Module (LVM) shall have the supervised Microphone and pre-amplifier. The module shall contain 6 programmable switches.

H. Zone Amplifiers capable of amplifying any one of the audio channels, for one or two channel applications.

I Audio input card to allow an external audio source.

J. A hard copy of the final system configuration, showing all inputs, outputs, descriptions, addresses, programming matrixes, etc., shall be supplied at no extra cost.

K. Fire alarm control panel shall provide a user programmable walk-test feature which can be customized to the particular application. This feature shall disable operator selectable evacuation signals and/or auxiliary functions during testing, provide audible indication of system operation, automatic reset, and historical logging to facilitate system testing by a single individual.

L. Fire alarm control panel shall be capable of supporting either addressable or hardwired inputs interchangeably by inserting the appropriate module(s).

M. The system software shall provide the following, additional features:

1) Sensitivity Setting by Sensor (within UL Limits)
2) Adjustment of Sensitivity Setting changed by the time (Day/Night Mode).
3) Multiple priorities for any event driven relay/output.
4) Enabling and Disabling of any system device or function.
5) Adjustable threshold Ground Fault Detection.
6) Programmable walk-test capability.
7) Modifying the software, a means to compare or an automaticate software check shall be provided to verify the original software integrity as outlined in NFPA 72.

2.02 ADDRESSABLE MONITOR MODULES:

A. Addressable monitor modules shall be provided for all non-addressable, normally open, fire alarm and supervisory alarm initiating devices, such as waterflow detectors and valve supervisory switches.

2.03 ADDRESSABLE RELAY MODULES

A. Addressable relay module shall include an addressable Form C relay and be controlled as a separate function at the same address.

B. Addressable relay module shall be provided to control a single normally open or normally closed dry contact for applications such as HVAC Controls interface (fan shutdown).

2.04 MANUAL FIRE ALARM PULL STATIONS

A. Manual fire alarm stations shall be installed where indicated on the drawings.

B. Manual fire alarm stations shall include an integral "double-action" mechanism, and appropriately labeled. All manual fire alarm stations shall be identical. Manual fire alarm stations requiring the use of "add-on" double action adapters are not acceptable.

C. Resetting the manual fire alarm stations after operation shall require the use of a "T-45" key or 9/16 inch Allen wrench. Manual stations which use a screwdriver for reset are not acceptable.

D. Manual fire alarm stations shall be surface mounted in unfinished areas, using appropriate back boxes and mounting hardware, on permanent walls or columns, 48" from the finish floor to the centerline of the manual fire alarm station. Surface mounted backboxes shall be smooth finished, red in color, and shall have no unused knockouts on the top or sides of the backbox.

E. Each manual fire alarm station shall be monitored individually, via either an integral addressable element, or where addressable element modules are used, those elements or modules shall be contained in the device backbox.

2.05 SYSTEM SMOKE DETECTORS

A. System smoke detectors shall be analog-addressable type, photoelectric installed where indicated on the drawings, ceiling mounted in conformance with the requirements of NFPA 72.

B. These detectors shall be system operated, photoelectric plug-in detectors as indicated on the bid drawings which mount to a twist lock base. The detector shall contain an alarm indicating LED which will illuminate to signal activation of the detector. The detector head shall be equipped with a mesh insect screen to prevent foreign objects from entering the sensing chamber. The sensitivity voltage shall be factory set by the manufacturer.

C. Removal of a smoke detector head from its base shall require the use of a special tool.

D. Spot-type smoke detectors shall have provision for calibrated sensitivity testing consistent with the requirements of NFPA 72.

E. The Subcontractor shall be responsible for protecting smoke detectors and smoke detector bases from dust, dirt, and paint contamination during construction and shall cover them with plastic bags or other suitable devices for the duration of the construction period. Detector covers shall be removed by the Subcontractor upon completion of the work in the area(s) in which they are installed.

F. Holes in the back of detectors and detector back boxes shall be covered with gaskets, sealant or equivalent, and detectors shall be mounted so that airflow from inside the detector back box or from the periphery of the detector housing shall not prevent the entry of smoke during a fire or test condition.

2.06 IN DUCT SMOKE DETECTION

A. In duct type smoke detectors shall be installed where indicated on the bid drawings, installed in conformance with the requirements of NFPA 72 and NFPA 90A, and in accordance with the detector manufacturer's installation instructions. In duct smoke detectors shall be suitable for the full range of air velocity conditions in the air handling systems in which they are installed.

B. In duct smoke detectors shall be system type, consisting of a plug in photo electric type detector head in a duct mounted housing equipped with air sampling tubes providing air flow through the detector housing. The detector housing shall accommodate either ionization or photoelectric type detector heads interchangeably. In duct smoke detectors shall be listed or approved for that application. In duct smoke detector operating voltage shall be 24 VDC.

C. Each in duct smoke detector shall be monitored individually as a “SUPERVISORY” without initiating evacuation devices or singaling a fire alarm via FIRUS. In-duct smoke detectors shall signal a supervisory alarm only via FIRUS.

D. In-duct smoke detectors shall be arranged to initiate shutdown of their associated fans on alarm from their associated control equipment via either dedicated reverse polarity notification appliance circuits or addressable control relays installed at the controlled equipment.

E. Both supply and return sampling tubes shall extend across the full width of the duct. The ends of the sampling tubes shall be sealed with removable plugs (to facilitate detector testing).

F. Sampling tubes shall be perforated type. Slot-type sampling tubes are prohibited.

G. Each in-duct smoke detector shall be provided with a functional key operated remote test station, incorporating a remote alarm led. Test stations shall be labeled with engraved, laminated plastic labels identifying the type of detector and detector

2.07 OPEN-AREA SMOKE IMAGING DETECTION

A. Open-area smoke imaging detectors (OSID) shall be Xtralis. Each OSID shall be provided with an internal heating element to prevent condensation on the optical surface and rest input from an external signal to reset the devices.

B. OSID operating power shall be supervised and shall be powered by the fire alarm control panel auxiliary 24 VDC.

C. OSID shall be installed at the locations indicated on the bid design drawings.

2.08 HEAT DETECTION

A. Thermal Detectors shall be rated at 135 degrees fixed temperature and 15 degrees per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 degrees Fahrenheit.

B. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage

2.09 AIR SAMPLING SMOKE DETECTION

A. Air-sampling smoke detectors shall be Xtralis VESDA detectors. Substitutions for this item are not acceptable.

B. Air-sampling smoke detectors shall be installed at the locations indicated on the bid drawings.

C. The control unit shall contain the required number of control cards. The control unit shall consist of an enclosure assembly, power supply, required number of batteries, and any additional componenets not specifically mentioned for a complete and fully operational system in compliance with the specification and drawing requirements.

D. The control unit shall be powered from a 120 VAC source and be monitored for alarm, pre-alarm (supervisory) and trouble conditions by the building fire alarm system. The panel shall have the following LED lamp indicators: 10 lamp bargraph, 3 alert level lamps, air flow lamp, detection failure and air flow failure lamps.

E. Piping shall be Chlorinated Polyvinyl Chloride (CPVC) Schedule 40 pipe. Pipe joints shall be airtight and permanently fixed by using a CPVC solvent cement.

F. Sampling ports in CPVC piping shall be pre-drilled/shop fabricated in accordance with the manufacturer’s drawings. Sampling ports shall be sized by vendor to equalize flow through each port. Each sampling port shall be identified by placement of a red label or sticker (with a hole punched in center) over the ports.

G. Sampling pipe system shall be of the closed end engineering design.

H. All air sampling piping systems shall be calculated, pneumatically balanced systems. Sampling rate (volume of air) shall be consistent, + or - 20%, between all air sampling locations.

I. Calculations shall be provided for all air-sampling smoke detection systems, as part of the Subcontractor's shop drawings.

2.10 LINE TYPE HEAT DETECTION

A. Line-type heat detection may require separate panel, such as Protectowire Panel Model Fire System 2000, two (2) zone panel.

B. Line-type heat detection shall be approved fixed temperature sensing elements comprising of two current carrying wires held separate by heat sensitive insulation for detection.

C. Any detection circuit which passes through an area protected by another circuit must be desensitized to prevent confusion of signals. This is accomplished by using copper wire for the required part of the circuit. Circuits shall be run in series loops and shall not have "T" or "Y" branches. Connection and splicing shall be in accordance with the manufacturer's recommendations.

D. All circuits shall terminate at both ends in an outlet box, cabinet, end-of-line resistor or other enclosure provided as part of the system. Copper wire may be used in making terminal connections inside conduit (EMT) tubing to connect sections of the circuit, in accordance with the manufacturer's recommendations.

E. The length of circuits shall not exceed the limits prescribed by the manufacturer.

F. Protectowire line-type heat detector, Type XCR at 190°F temperature rating or approved equal, shall be used in all areas unless noted otherwise on drawings.

G. Automatic line-type heat detector of the type and temperature rating specified shall be installed at the ceiling level. The meter shall be located in Sub-Fire Control Panel.

H. All details of the installation should be performed in a neat and workmanlike manner. All bending and fitting of line detector shall be done with the fingers. Pliers or other tools shall not be used for this purpose. Only fastening devices furnished or approved by the manufacturer shall be used to support the line heat detector.

I. The line detector shall be enclosed in conduit wherever it is connected to manual fire alarm stations, test terminals, junction boxes, etc. Open ends of the metal conduit through which the detector passes shall be provided with bushings. After the control panel is mounted and all conduit and wiring installed, the panel doors shall be left closed. Both ends of all conduit or wireways which connect to the control panel shall be completely closed off with duct seal.

J. Install two (2) junction boxes on 24 inches intervals with splicing terminals on the line-type heat detection, so that 24 inch section of the line type heat detector can be removed by disconnecting the splicing terminals. Coordinate location with Fermilab. Upon completion of the installation, the Subcontractor shall furnish at no charge two Alarm Point Locator Model APL-90 Meter Adapter and two Manual Fault Locator System Model MFL-92. These devices shall be given to Fermilab.

2.11 EVACUATION (NOTIFICATION APPLICANCES) SIGNALING DEVICES

A. Evacuation signaling shall be provided by combination Audible/Visual (A/V) units comprised of a fire alarm speaker and strobe light assembled in a common housing.

B. The speaker portion of the combination A/V units shall provide an audible output on alarm of 90 dBa at 10 feet measured on axis. The strobe light portion of the combination A/V unit shall be rated to provide a minimum output of 75 candela; in conformance with the requirements of the Americans with Disabilities Act.

C. Operating voltage shall be 24VDC.

D. All audible devices shall be installed to provide the minimum required sound output for the ambient background noise in accordance with NFPA 72.

2.12 SYNCHRONIZATION OF AUDIBLE AND VISUAL ALARM SIGNALS

A. The A/V alarm signal shall be synchronized. The audible alarm signal shall be synchronized so as top provide clear tone without echo effect. The visual alarm signal shall be synchronized.

B. Synchronization shall be accomplished with the use of sync modules for synchronizing all visual (strobes) within the building simultaneously.

2.13 WATERFLOW ALARM DETECTORS

A. It is this subcontractor's responsibility to wire and connect these devices to the fire alarm system. This installation shall include all appurtenances necessary with the exception of the devices themselves.

B. Waterflow switch retard settings shall be set and/or adjusted under this Section, to between 30 seconds (minimum) and 60 seconds (maximum).

C. Waterflow alarm detector shall be manufactured by Potter, Vane Type series. Each waterflow switch shall be monitored individually.

2.14 SPRINKLER SUPERVISORY DEVICES

A. It is the subcontractor's responisibilty to wire and connect these devices to the fire alarm system. This installation shall include all appurtenances necessary with the exception of the devices themselves.

B. All valve supervisory switches and supervisory air supervisory pressure switches shall be wired and tested under this Section.

C. Valve supervisory switch shall be manufactured by Potter, Model OSY-2 and Air Supervisory Switch shall be manufactured by Potter. Each valve supervisory switch shall be monitored individually.

2.15 AUXILIARY FUNCTION RELAYS/CONTROL MODULES

A. All required auxiliary functions shall be initiated using addressable control relays.

B. All auxiliary function circuits, between the addressable control relay and the controlled mechanical equipment, shall be supervised by the fire alarm system.

C. Intermediary relays shall be provided between the addressable control relay and the controlled mechanical equipment, as necessary to provide contacts rated for the application. Where intermediary relays are provided they shall be installed within 3 feet of the controlled mechanical equipment; supervision of auxiliary function between intermediary relays and the controlled mechanical equipment is not required.

D. Proper operation of auxiliary functions shall not cause a trouble signal.

2.16 END-OF-LINE POWER SUPERVISORY RELAYS

A. End-of-line power supervisory relays shall be installed at the end of the monitored circuit and shall be arranged such that their operation upon power loss does not impair the receipt of signals from any device not already impaired by the power loss, and does not cause the loss of power to any additional device(s).

B. End-of-line power supervisory relays shall be provided for each 24VDC power circuit used for powering peripheral devices, 4-wire detectors, addressable control modules, etc.

PART 3 SYSTEM OPERATION/SEQUENCE OF OPERATIONS

3.01 GENERAL REQUIREMENTS: The fire alarm system shall monitor and annunciate three distinct types of signals:

A. Fire alarms, including signals initiated by manual fire alarm stations, smoke detectors (confirmed signals only), heat detectors, and sprinkler system waterflow detectors.

B. Supervisory signals initiated by sprinkler valve supervisory switches.

C. Trouble conditions, including signals initiated by the system in response to fault conditions detected in supervised circuits and/or components.

3.02 FIRE ALARM SIGNALS

A. All fire alarm signals shall be annunciated both audibly and visibly at the fire alarm control panel.

B. Fire alarm signals shall initiate evacuation signals, visual signals and/or alarm signals throughout the building.

C. Fire alarm signals shall be retransmitted to Fermilab Comm Center via FIRUS, as required elsewhere in these Specifications.

3.03 SUPERVISORY SIGNALS

A. Supervisory signals shall be annunciated both audibly and visibly at the fire alarm control panel.

B. Supervisory signals shall be retransmitted to the Fermilab Comm Center via FIRUS, as required elsewhere in these Specifications.

C. Supervisory signals shall not initiate evacuation signals.

3.04 TROUBLE SIGNALS

A. Trouble signals shall be annunciated both audibly and visibly at the fire alarm control panel.

B. Trouble signals shall be retransmitted to the Fermilab Comm Center via FIRUS, as required elsewhere in these Specifications.

C. Trouble signals shall not initiate evacuation signals.

3.05 SYSTEM OPERATION ON STANDBY BATTERY POWER

A. Upon failure of normal (AC) power, the affected portion(s) of the systems(s) shall automatically switch over to battery power without disruption of normal system annunciation or operation.

B. Operation of the system on standby battery power shall be identical to operation of the system on normal AC power, except that operation of the system on standby battery power shall cause a trouble signal and shall be limited in duration by the capacity of the standby batteries. All detection, evacuation signaling, signal retransmission, signal annunciation, and auxiliary function operations shall be unaffected by the changeover to standby battery power.

PART 4 INSTALLATION

4.01 GENERAL REQUIREMENTS FOR INSTALLATION OF CONDUITS, RACEWAYS, ENCLOSURES, J-BOXES, PULLBOXES, AND BACK BOXES

A. The requirements of this section apply to all fire alarm conduits, raceways, electrical enclosures, junction boxes, pullboxes and device back boxes.

B. Fire alarm system conduit systems shall be dedicated to the fire alarm system and shall contain no unrelated conductors.

C. All fire alarm conduit systems shall be routed and installed to minimize the potential for physical damage, mechanical or by fire, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance.

D. All fire alarm conduits, except flexible conduit whips to devices, shall be solidly attached to building structural members, ceiling slabs or permanent walls. Conduits shall not be attached to other conduit, duct work, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, evacuation signaling or auxiliary function devices.

E. Acceptable fasteners include toggle bolts on hollow masonry walls, concrete inserts or expansion shells on concrete or brick, and machine screws, welded threaded studs, or spring tension clamps on steel work.

1. Design load applied to fasteners shall not exceed 25% of the rated load for the fastener used.

2. Fasteners attached to concrete ceilings shall be vibration and shock resistant.

3. Holes cut to a depth of more than 1.5 inches in reinforced concrete beams or to a depth of more than 0.75 inches in concrete joists shall not cut the main reinforcing bars. Holes not used shall be filled.

F. All fire alarm system conduits shall be routed/installed either parallel or perpendicular to building structural members. Changes in direction shall be

made with symmetrical bends or cast-metal fittings. Field-made bends shall be made with a "Hickey" or conduit-bending machine.

G. All fire alarm system conduits shall be installed at a height so as not to obstruct any portion of a window, doorway, stairway or a passageway, and shall not interfere with the operation of any mechanical or electrical equipment.

H. Crushed or deformed conduits shall not be installed.

I. All fire alarm system conduits, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device back boxes shall be readily accessible for inspection, testing, service and maintenance.

J. Fire alarm system conduits shall be arranged to reduce the possibility of water in those conduits draining through control panels. Conduits shall be arranged to enter control cabinets from below.

K. Locknuts and insulated bushings shall be provided at the termination of all conduits. In areas subject to vibration, locknuts shall be secured with "Loc-Tite" or approved equal.

L. The Subcontractor shall be responsible for ensuring that conduits are not obstructed with plaster, dirt, trash, or other foreign objects. Clogged conduits shall be replaced at the Subcontractor's expense.

M. Conduits shall maintain a 6 inch minimum clearance from all flues, steam pipes, and hot water pipes.

N. All exposed conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.

4.02 TYPES OF CONDUIT

A. For flexible metallic conduit used for whips to devices only, maximum length 6 feet.

B. All other fire alarm conduits shall be EMT, except for flexible metal conduit used for whips to devices only, maximum length 6 feet.

4.03 CONDUIT SIZING

A. Conduits shall be sized according to the conductors contained therein. Cross sectional area percentage fill for fire alarm system conduits shall not exceed 30%, in accordance with NEC Table 9.

B. Minimum conduit size shall be 3/4".

4.04 CONDUIT FITTINGS

A. All EMT fittings shall be compression type, weatherproof where installed in damp or wet locations.

B. All conduit fittings for rigid conduits shall be threaded, sealed using Teflon tape.

4.05 SEPARATION OF CONDUCTORS

A. Fire alarm conductors shall be separated into two categories:

1. Data circuits, including signaling line circuits, etc., and low voltage non-data circuits, including notification appliances circuits.

VOICE/PHONE JACKS MAY REQUIRE SEPARATION

2. AC power circuits.

B. Each category of fire alarm conductors shall be installed in physically separated, dedicated conduits, and shall not interface with one another except at common associated control equipment. Addressable modules or elements used to provide system “addresses” for non-addressable-type initiating devices shall be considered “control equipment” for the purposes of this section. Fire alarm system conductors shall be further segregated as necessary to prevent electrical and/or audio crosstalk between conductors installed in common conduits.

4.06 GENERAL REQUIREMENTS INSTALLATION OF CONDUCTORS, CABLES AND DEVICES

A. The requirements of this section apply to all fire alarm system conductors, including all signaling line, initiating device, notification appliance, auxiliary function, remote signaling, AC and DC power and grounding/shield drain circuits, and any other wiring installed by the Subcontractor pursuant to the requirements of these Specifications.

B. All fire alarm system conductors shall be:

1. New. Wire that has scrapes, nicks, gouges or crushed insulation shall not be used.

2. UL listed.

3. Installed in conduit or enclosed raceway.

4. Continuous (except bare shield drain conductors) between devices and between devices and intermediary terminal cabinets.

5. Addressable circuits shall be 18 AWG solid twisted jacketed cables, minimum. Notification appliance circuits shall be 14 AWG solid, minimum. AC power circuits shall be 12 AWG stranded, minimum.

Where the system manufacturer's installation recommendations require larger conductors, larger conductors shall be provided.

4.07 TYPES OF CONDUCTORS AND CABLES

A. All low voltage fire alarm circuits shall be installed as non-power limited circuits in accordance with Article 760 of NFPA 70. All other fire alarm circuits shall be installed in accordance with the applicable requirements of NFPA 70, 2005 edition.

B. All fire alarm system conductors, shield drain conductors and grounding conductors, shall be solid copper or bunch tinned (bonded) stranded copper. Stranded copper conductors are acceptable for shield drain conductors and grounding conductors only.

C. All signaling line circuits, including all addressable initiating device circuits shall be multi-conductor jacketed twisted cable.

D. All non-addressable initiating device circuits shall be twisted pairs. Notification appliance circuits auxiliary function circuits, and AC power circuits shall be THHN/THWN parallel conductors.

E. The use of aluminum wire is prohibited.

4.08 WIRING METHODS

A. Splices in fire alarm system conductors are specifically prohibited, except for soldered and taped splices in shield drain conductors, as necessary to maintain continuity of the shield between devices. All splices shall be mechanically secure before soldering.

B. All fire alarm conductor termination’s, except splices in shield drain conductors, and including field connections to supervisory resistors, diodes, relays or other devices, shall be to numbered terminals or terminal strips and shall be readily accessible for inspection, service, testing and maintenance.

1. All fire alarm conductor termination’s shall be within junction boxes, device back boxes, terminal cabinets, control panels or other suitable metal enclosures.

2. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.

3. Each conductor termination shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on the Subcontractor's record drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of all conductor terminations.

4. All terminations are subject to the approval of Fermilab.

C. All control panel wiring shall be fully dressed and bundled with nylon tie wraps at 3-inch intervals. Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90° angles to their associated terminal connections. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between AC power conductors and low voltage conductors wherever possible. All control cabinets shall be sized to accommodate the requirements of this Paragraph.

D. Control panels shall not be used as raceways. Conductors which do not terminate within a control panel shall not be routed through that control panel.

E. Conductors looped around terminals are not acceptable.

F. Wire nuts appropriately sized for the gauge of wires, are acceptable in junction boxes only. Wires shall be stripped, mechanically twisted, and trimmed prior to installing wire nut. Wire nuts shall be secured with electrical tape, "Crimp" or "Self Stripping" wire connectors are not acceptable.

G. T-tapping of fire alarm circuits is prohibited, unless approved by the Engineer.

4.09 DEVICE BACKBOXES/TERMINAL CABINETS/JUNCTION BOXES/PULL BOXES

A. Junction boxes may be installed as necessary to minimize the overall length of conduit required, consistent with these Specifications. All conductors shall be pulled through junction boxes, without splices.

B. Pullboxes shall be installed in each fire alarm system conduit at intervals not to exceed 100 feet. Pullboxes shall be 4-inch square, minimum.

C. Terminal cabinets may be installed as appropriate where distance or number of conduit bends make continuous conductors between devices impractical.

1. Terminal cabinets shall be 6 x 6 x 4 inches minimum, provided with pressure-plate type barrier terminal strips and screw mounted covers. Terminal strips shall be securely and permanently mounted to the cover of the terminal cabinet. Terminals shall be clearly numbered with indelible marker for identification, using a consistent numbering convention throughout the project.

2. Terminal cabinets shall be readily accessible for inspection and servicing. Terminal cabinet locations requiring the use of scaffolds or ladders over 6 feet in length for inspection and servicing will not be accepted.

D. All device back boxes, junction boxes and terminal cabinets shall be sized to accommodate the number of conductors contained therein, extension rings or extension boxes are not acceptable.

E. All device backboxes, junction boxes, and terminal cabinets shall be listed for outdoor use where installed in damp or wet locations.

4.10 SHIELDED CABLES

A. All fire alarm circuits shall be twisted and shielded as recommended by the system manufacturer(s) and as necessary to prevent electrical and/or audio crosstalk between conductors installed in common conduits.

B. All conductor shielding shall be continuous (with splices) for the length of the circuit, grounded at the associated control panel only.

C. Shield drain conductors and foil shall be trimmed and taped at each splice to prevent grounding of the shield at any location other than the associated control panel.

4.11 GENERAL REQUIREMENTS FOR PATCHING

A. Removal, modification, and repair of all finished surfaces shall be coordinated with, and is subject to the approval of the Construction Coordinator.

B. The fire alarm system Subcontractor shall be responsible for all patching and touch-up painting necessitated by the performance of his work.

4.12 FIRESTOPPING

A. All holes made by the Subcontractor in or through walls, floors and ceilings shall be sealed around the conduit(s) by the fire alarm Sub-Contractor, restoring the walls, floors and ceilings to their original condition, fire resistance and integrity.

B. Firestopping in fire rated walls and floor slabs shall be accomplished using a durable, UL-listed firestop assembly providing a fire rating equivalent or greater to that of the fire barrier. Firestopping material shall be manufactured by 3M or Hilti.

4.13 PAINTING:

A. All fire alarm system conduit, pull boxes, junction boxes and terminal cabinets covers shall be painted "fire engine red" prior to installation. The Subcontractor shall provide touch-up painting, of normally visible pull boxes, junction boxes and terminal cabinets prior to final acceptance testing.

4.14 GENERAL REQUIREMENTS FOR SYSTEM TESTING

A. The fire alarm system shall be tested and documented in accordance with the requirements of these Specifications and approved test protocols prepared by the Subcontractor as outlined in Paragraph C.1.14.

B. System testing shall include three distinct phases as follows:

1. Insulation testing of all new system wiring with a meggar, performed and documented by the Subcontractor. This testing shall be completed prior to connection of any electrical devices.

2. A 100% test of all control equipment, annunciation devices, detectors, notification appliances, remote signaling apparatus, and auxiliary functions, performed and documented by the Subcontractor.

3. An Acceptance Test performed and documented by the Subcontractor, in the presence of the appropriate Fermilab representatives.

C. Fermilab reserves the right to witness all Subcontractor testing. Fermilab shall be given 5 working days (minimum) notice of all tests; 10 days for the acceptance test.

D. The Subcontractor shall provide all materials, equipment, coordination and personnel necessary to perform and document all required tests. All test equipment shall be subject to the approval of Fermilab.

4.15 INSULATION TESTING

A. All fire alarm system conductors shall be tested for integrity of insulation, prior to connection of any equipment, using a meggar operating at 500 Volts; two (2) minutes per circuit, minimum. This testing shall be coordinated with the installation schedule to prevent over-voltage damage to system components.

B. All test values shall be recorded in ohms. All circuits measuring less than 10M ohms to ground, or between conductors installed in the same conduit, shall be replaced.

C. Upon completion of insulation testing, the Subcontractor shall provide written certification to Fermilab documenting successful completion of all required insulation testing in accordance with these Specifications.

4.16 SUBCONTRACTOR'S 100% TEST

A. All alarm initiating devices, notification appliances, auxiliary function relays, control panels, annunciation equipment, FIRUS connections, standby power supplies and associated circuits shall be functionally tested to verify proper operation and supervision.

B. Correct annunciation of all alarm, supervisory and trouble conditions, including any user programmable text messages, shall be verified.

C. Correct operation of all automatic auxiliary functions shall be verified.

D. Proper automatic transmission of fire alarm, supervisory alarm, and trouble signals via the FIRUS system shall be verified.

E. The Subcontractor's 100% test shall be conducted with the final system program installed in non-volatile memory. In the event that errors are identified in the system program, the program shall be corrected and all required testing repeated with the new software iteration. The intent of this paragraph is that all required system tests, except insulation testing, be conducted with the final system program installed.

F. Upon completion of Subcontractor's Operational and Supervisory Testing, the Subcontractor shall provide written certification to Fermilab documenting successful completion of all required tests in accordance with these Specifications.

4.17 FERMILAB'S ACCEPTANCE TEST

A. Upon completion of the project, an Acceptance Test of the fire alarm system shall be performed in the presence of Fermilab's designated Representative(s).

1. In preparation for the Acceptance Test, the Subcontractor shall submit As-built Drawings, as required elsewhere in these Specifications.

2. The Subcontractor's As-built Drawings will be reviewed for conformance to the applicable Specification requirements. Upon approval of the As-built Drawings, Fermilab will mark up one copy to reflect the Acceptance Test plan.

B. The Acceptance Test will be directed by Fermilab in accordance with the Acceptance Test plan. The Acceptance Test shall be performed by the Subcontractor and shall include at a minimum:

1. Functional testing of 100% of the initiating devices.

2. Functional testing of 100% of the evacuation signaling devices. This testing shall include audibility testing with a dBa meter.

3. Supervisory testing of 100% of the initiating devices and 100% of the initiating device circuits.

4. Supervisory testing of 10% of the evacuation signaling devices and 100% of the evacuation signaling circuits.

5. Supervisory testing of all power supplies/standby batteries.

6. Functional testing of all auxiliary functions.

7. Two, consecutive full load tests (all fire alarm initiating devices in alarm and all evacuation signals, annunciators and auxiliary

functions activated simultaneously), one under standby battery power and one under normal power, 15 minutes duration each, minimum.

8. Verification of proper annunciation of all signals.

9. Verification of proper automatic transmission of fire alarm, supervisory alarm, and trouble signals via FIRUS.

10. Verification of proper system operation under a variety of fault conditions, including power failures, opens, ground faults, and short circuits.

11. Any additional tests deemed necessary by the Fermilab Representative(s) witnessing the testing.

C. 100% successful performance during Acceptance Testing is expected, based on the Subcontractor's Insulation Testing Documentation and 100% Test Certification required, in accordance with NFPA 72. In the event of system performance inconsistent with the Subcontractor's testing certifications, Fermilab will make a determination as to whether or not the test results constitute failure of the Acceptance Test. Failure of the Acceptance Test shall invalidate the Subcontractor's System Certification, in which case recertification (including 100% Subcontractor retesting) and a repeat of the Acceptance Test shall be required at no additional cost to Fermilab.

4.18 TRAINING FOR FERMILAB FIRE DEPARTMENT AND BUILDING SERVICES PERSONNEL

A. Upon project completion, the Subcontractor shall provide on-site training for Fermilab Fire Department & Fire System Maintenance personnel.

4.19 WARRANTY

A. The Subcontractor shall warranty all materials, equipment and workmanship for in-service portions of the fire alarm system during the installation period and thereafter, for a period of one year, including the following related services:

1. Provide emergency service for the new fire alarm systems, or for in-service portions thereof, within four hours of a request for such service by Fermilab during the installation and warranty periods. This service shall be provided on a 24-hour per day, seven days per week basis, without additional cost.

2. The Subcontractor shall provide regularly scheduled testing and normal system maintenance, in accordance with the requirements of NFPA 72, 2013, for in-service portions of the system during the construction period, and thereafter, for the completed system until such time as it has been accepted by Fermilab.

3. If Fermilab experiences more than two spurious or unexplained false alarms in any 48-hour period, while the system is under warranty, the Subcontractor shall, upon request, provide the necessary labor, material and technical expertise to promptly correct the problem(s) without additional cost.

B. The warranty period shall begin upon Final Approval and Acceptance of the completed system.

END OF SECTION 16721