TYPE B FINAL SUBMITTAL
PROJECT SPECIFICATIONS

KC-135 FLIGHT TRAINING UNIT FACILITY

(Addition to Flight Simulator Training Facility)
VDYD989075

126th AIR REFUELING WING
ILLINOIS AIR NATIONAL GUARD
SCOTT AIR FORCE BASE
BELLEVILLE, ILLINOIS

Bid Documents
July, 2001

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SECTION 01001
GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 JURISDICTIONS

A. The Project Work Site, Scott Air Force Base, is a U.S. military installation and as such, all aspects of the Work on the site shall be subject to the requirements herein.

B. The CONTRACTOR (CONTRACTOR) shall coordinate all activities for compliance with these requirements through the Contracting Officer's Technical Representative (COTR). CONTRACTOR shall notify COTR at least 48 hours before authorization, coordination, or notification is required from the appropriate organization at Scott AFB (SAFB), unless otherwise noted.

1.2 SAFETY

A. Base and Safety Regulations:

1. These requirements are in addition to those that are contained in FAR Clause 52.236-13, "Accident Prevention;" and DFARS Clause 252.236-7005, "Airfield Safety Precautions."
2. The CONTRACTOR shall comply with all applicable provisions of the Corps of Engineers Manual, EM 385-1-1, entitled "General Safety Requirements," and Air Force regulations and directives pertaining to security, safety, fire, traffic, and personnel clearances insofar as they pertain to the CONTRACTOR's activities on SAFB.
3. The CONTRACTOR shall be responsible for providing, placing, and removing all barricades and safety devices during his construction activities.
4. In addition, the CONTRACTOR shall:
   a. Not operate vehicles or enter the runway or flight line.
   b. Yield to all emergency vehicles including security police, fire department, ambulance, and ambulance buses when their red lights and/or sirens are operating.
   c. Stop on the roadway at the ends of the runway when the red lights are flashing or illuminated. Remain stopped until the red light goes out.
   d. Coordinate movement of heavy/oversized equipment such as cranes, extended flat bed trailers and large earth moving vehicles with the base security police (256-3674) through the COTR.
   e. Provide personnel to direct traffic when CONTRACTOR-operated vehicles block one or both lanes of a two-lane road.

5. If a mishap involves injury or death to CONTRACTOR personnel and/or damage to Air Force property as a result of CONTRACTOR operation, the CONTRACTOR shall notify the Contracting Officer (Contracting Officer) and COTR, the COTR will contact the Wing Safety Office at 256-6311 on normal workdays or the Scott Command Post at 256-5891 at any other time. Any safety-related problems encountered during the contract period should be reported to the COTR who will advise Wing Safety. In case of life-threatening emergency, dial 911 to reach the Security Police, Fire Department, or ambulance. Emergency treatment for serious or life-threatening injuries is available at the Scott AFB Medical Center to the extent necessary to stabilize the patient and prevent undue suffering.
6. The CONTRACTOR shall ensure compliance with contract, OSHA, and AFOSH provisions.

B. Site Security:

1. CONTRACTOR shall provide a temporary safety fence with gates and warning signs at the construction site prior to the start of work to protect members of the public from construction activities and as necessary to protect the Work and CONTRACTOR-furnished products not yet installed. The safety fence will enclose those areas not within the existing construction fence. The construction fence may be used in lieu of a safety fence. The safety fence shall be brown in color or bright orange when protecting excavated areas, high density polyethylene grid or approved equal, a minimum of 1.1 m (42 inches) high, supported and tightly secured to steel posts located on minimum 3-m (10-foot) centers, constructed at the approved location. The safety fence shall be maintained by the CONTRACTOR during the life of the contract and, upon completion and acceptance of the Work, shall remain the property of the CONTRACTOR and shall be removed from the work site. CONTRACTOR shall retie fabric on the existing construction fence and stabilize end posts. Existing construction fence shall be removed in its entirety from the work site upon completion and acceptance of the Work.

C. Barricades and Lights:

1. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and parking lots, inside and outside of fenced area, and as required to ensure public safety and the safety of CONTRACTOR's employees, other employer's employees, and others who may be affected by the Work.
2. Provide to protect existing facilities and adjacent properties from potential damage.
3. Locate to enable access by facility operators and property owners.

D. Safety Briefing:

1. CONTRACTOR shall brief subcontractors on safety and fire prevention regulations, emphasizing the requirement to obtain a welding permit, when welding, cutting and brazing operations are required, and obtain authorization from the Base Fire Chief, through the COTR, when open burning is intended.
2. Maintain documentation that all subcontractors have been briefed.

1.3 HAZARDOUS MATERIAL USAGE

A. The CONTRACTOR shall establish a hazardous material (HM) storage and distribution system when HM is to be used. All HM required to support the contract shall be reported to the Hazardous Material Pharmacy (HMP) and the Bio Environmental Engineering Office (BEEO) using the CONTRACTOR HM Identification Form. The CONTRACTOR HM Identification Form will be provided to the CONTRACTOR at or prior to the Preconstruction meeting. Additional HM needed by the CONTRACTOR shall be identified to the CONTRACTING OFFICER's Representative for approval by the HMP. See Supplements as appended hereto.

B. The CONTRACTOR planning to use HM for the work must register with the base HMP prior to start of work in order to support the installation's compliance with Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements.

C. The CONTRACTOR shall maintain CONTRACTOR HM Identification Form for HM on the jobsite for inspection/verification.

D. CONTRACTING OFFICER's Representative will verify that the HM identified to HMP is the only HM in use on the jobsite.

E. CONTRACTOR shall provide the HMP:

1. A list of each material and quantity of material or all proposed HM. Hazardous Material (HM) shall mean any item that is:
   a. A health hazard or physical hazard as defined in 29 CFR, 1910.1200(c).
   b. Regulated in its disposal by EPA under 40 CFR.
   c. Hazardous as defined by DOT regulations under 49 CFR.
   d. Hazardous as defined by the Dangerous Goods Regulations of the International Air Transport Association.
2. A material safety data sheet (MSDS) for each item on the list.

F. The CONTRACTOR shall establish his/her own HM storage and issue location that complies with federal, state, and local environmental regulations. Materials issued shall be tracked for quantities used. Unused materials shall be

inventoried and removed from the ANG installation prior to closeout of the contract or expiration date of the HM. Reports of materials delivered, used, and removed from the installation shall be submitted to the CONTRACTING OFFICER monthly and prior to contract closeout.

G. The CONTRACTOR shall comply with all federal, state, and local environmental standards.

H. The CONTRACTOR shall accompany the Base Environmental Engineer (BEE) on project closeout inspection to ensure all used/unused HM was removed from the installation.

1.4 FIRE PREVENTION STANDARDS

A. The following is information pertaining to fire prevention standards at Scott Air Force Base. These standards apply to all new construction and reconstruction, demolition, rehabilitation, alteration and modification.

B. Serious fires can occur due to accumulation of combustible materials or debris and the presence of ignition sources. Basic safeguards against construction fire hazards must be provided for during project planning. These standards outline measures which, with some pre-planning, will prevent fires or, at least minimize damage if a fire does occur.

C. Responsibilities:

1. A fire department representative will attend preconstruction conferences to brief the CONTRACTOR on pertinent fire regulations and to provide guidance for fire-safe operations during contract performance. Fire Prevention guidance appropriate to the contract will be furnished the CONTRACTOR for briefing his personnel.
2. The CONTRACTOR will furnish to the fire department Fire Prevention Section at 256-3378 or 5130 via the COTR with the name(s) of responsible individuals, who, in case of a fire after normal work hours, can be notified of an incident.
3. The CONTRACTOR shall be responsible for assuring proper availability, operation and location of fire protection equipment, general supervision of safeguards and location of salamanders or portable heating equipment, and establishment and maintenance of safe cutting and welding operations.
4. To report a fire, dial 911.

D. Water Supply:

1. The CONTRACTOR will ensure an adequate water supply for fire protection is available whenever combustible materials accumulate.

2. Temporary connection to a main or fire hydrant by a contractor will first be coordinated through the COTR with a fire department representative at 256-3378 to ensure availability of water supply for fire protection is not jeopardized.
3. Any connection to the public potable water supply must comply with Illinois Plumbing Code using an approved cross-connection device and be coordinated with 375 CES/CEOI at 256-1686 (utilities) through the COTR.

E. Access for Firefighters:

1. Access for use of firefighting vehicles will be provided to the immediate job site at the start of construction and maintained until all construction is complete. Vehicle parking control measures will be established that will allow firefighters access to the construction site.
2. Free access from the street to fire hydrants and to outside connections for standpipes, sprinklers, or other fire extinguishing equipment, whether permanent or temporary, shall be provided and maintained at all times. No material or construction will be placed within 10 feet of hydrants or connections, or between hydrants and the centerline of the street.
3. Fire hydrants in excavations will be rigidly braced and protected from freezing.
4. Scaffolding, materials, or equipment will not block fire escape routes during performance of projects in occupied buildings.
5. In buildings over 30 feet in height, at least one stairway will be provided in usable condition at all times. This stairway will be extended upward as each floor is installed. For buildings less than 30 feet in height, safe methods for ascending/descending will be provided in accordance with standard industry practice.

F. In accordance with AFM 91-201, Explosives Safety Manual, if storing more than 1,000 nail gun cartridges, approval must be requested from Wing Safety at 256-6311 through the COTR.

G. The CONTRACTOR will notify the Fire Prevention representative, through the COTR, whenever an existing fire detection, alarm, or extinguishing system must be disconnected, relocated, or extended. Fire Protection system components will be handled carefully to assure reliability when the system is restored to service.

H. Any fire hazard or condition that is not specifically covered by these specifications that is recognized by anyone will be immediately brought to the attention of supervisors or anyone having authority to stop the operation.

I. For any further fire prevention guidance or specifics, contact the COTR.

1.5 STANDARD WORKDAY/WEEK

A. Work shall normally be accomplished Monday through Friday, between the hours of 7:00 a.m. and 4:30 p.m. local time, excluding national holidays and non-work days resulting from holidays occurring on weekends.

B. When the CONTRACTOR desires to work at other than the aforementioned times, he shall submit a written request to the Contracting Officer via the COTR for approval, and written approval thereof shall be required prior to proceeding with work.

1. The request shall be submitted at least three work days prior to the proposed performance of work.
2. The request shall indicate the day/days, time/amount of work, and reason why permission should be granted to perform work during nonstandard hours.
3. Approval for work to be performed during nonstandard time will be given only in cases of extreme necessity.

1.6 CONSTRUCTION PERMIT

A. The CONTRACTOR shall obtain, through the COTR, an AF Form 103—Base Civil Engineer Work Clearance Request (hereafter referred to as a "digging permit"), from the CEP (Civil Engineering, Planning), Building 528. The purpose of the permit is to locate, prior to excavation, all known underground utilities.

B. The CONTRACTOR shall initiate the request for a digging permit a minimum of five (5) working days prior to performing any excavation or ground penetration.

C. The CONTRACTOR shall clearly mark the location of the excavation or ground penetration with white, water soluble, spray paint, or white utility marking flags. The CONTRACTOR shall ensure the markings are maintained until the area is cleared by all responsible agencies or offices for each utility.

D. The CONTRACTOR shall also show the identified area on a site plan. The site plan shall clearly delineate the proposed work area, nearest building, the nearest cross street to the location of digging. The CONTRACTOR shall provide this site plan to CEP when requesting the digging permit. In the event that a representative for the designated utility does not respond to the locating request, the CONTRACTOR shall immediately notify the COTR.

E. After identified utilities have been cleared through each affected agency or office and the CEP, the CONTRACTOR will receive a copy of the digging permit. The CONTRACTOR must have the digging permit on the job site during the excavation process.

F. The CONTRACTOR shall exercise every precaution during excavation to prevent damage to the existing utilities. The CONTRACTOR shall immediately notify CEP if any utilities are damaged during the location or excavation process.

1.7 HOT WORK PERMIT

A. The CONTRACTOR shall obtain from the Scott AFB, Base Civil Engineer (BCE), through the COTR, a permit for any welding or flame cutting operations prior to initiating such operations. Permits are available from the CEP, Building 528. A minimum of two fire extinguishers shall be at the site of all open welding or flame cutting operations.

B. The CONTRACTOR shall initiate the request a minimum of five (5) working days prior to performing any hot work.

1.8 CONFINED SPACE PERMIT

A. The CONTRACTOR shall obtain from Scott AFB, 375th Base Civil Engineer, at (618) 256-4823, through the COTR, a Confined Space Permit prior to entry into any existing Base confined space.

B. A confined space shall be as defined in OSHA.

C. The CONTRACTOR shall initiate the request a minimum of five (5) working days prior to entry into any existing Base confined space.

1.9 24-HOUR POINT OF CONTACT

A. The CONTRACTOR shall provide the Contracting Officer and COTR with a 24-hour number or numbers where his authorized representative can be contacted at anytime day or night. Also provide call forwarding capability for leaving a message. This number should be provided prior to any on site performance at the preconstruction conference, but not later than ten (10) days after the Notice to Proceed is issued.

1.10 UTILITIES AND SERVICES

A. The CONTRACTOR shall be permitted the use of all reasonably required amounts of utilities (water, electric, and sewer) from the GOVERNMENT's existing system outlets.

B. In addition to requirements contained in FAR Clause 52.236-14, "Availability and Use of Utility Services," temporary utility connections shall be at the CONTRACTOR's expense and installation shall include metering and be subject to the approval of the Contracting Officer and the COTR. The

CONTRACTOR shall provide telephone and other services required for the work.

C. If portable sanitary facilities are utilized, said facilities are subject to the approval of the Contracting Officer, through the COTR, as to the location, cleanliness, and maintenance. All temporary sewer/sanitation facilities shall be self-contained units with both urinals and stool capabilities. The units shall be sufficiently ventilated to control odors and fumes and should be emptied and cleaned at least every week or more often if required by the Contracting Officer. The doors should be self-closing. The exterior color of the unit shall be "expresso" (Brad Dugan No. 5765N, or similar color) or "apache" (Brad Dugan No. 5213M, or similar color). The facility will be located behind the construction fence or out of the public view. Use of Government facilities will not be authorized.

1.11 UTILITY SERVICE INTERRUPTIONS

A. The CONTRACTOR shall submit written notification to the COTR not less than five work days in advance for each planned interruption of a utility service.

B. No single interruption shall exceed 8 hours.

C. Utility service interruptions shall not be permitted unless approved by the Contracting Officer and COTR.

D. Service interruptions shall be accomplished at other than normal work hours if feasible.

1.12 DUST CONTROL

A. The CONTRACTOR shall maintain all excavations, embankments, stockpiles, access roads, and all other work areas free from excess dust to such reasonable degree as to avoid causing a hazard or nuisance to base personnel or surrounding facilities.

B. Approved temporary methods consisting of sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted to control dust. Provide material submittal for approval of method to be used.

C. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs.

1.13 PATCHING AND REPAIRING

A. After the work has been completed, any CONTRACTOR-caused damages to Scott AFB-owned structures, facilities, streets, curbs, walks, lawns, etc., shall

be properly patched, repaired, or replaced to the complete satisfaction of the Contracting Officer, through the COTR.

B. Any holes, cuts, breakage's, and damages made in finished surfaces of the area in which work has been accomplished, shall be properly repaired and the disfigured areas then painted over or otherwise repaired and resurfaced in kind to match the existing finishes to the complete satisfaction of the Contracting Officer, through the COTR.

1.14 DISPOSITION OF REMOVED GOVERNMENT PROPERTY

A. All materials and equipment to be removed by the CONTRACTOR and not reinstalled under this contract, including debris generated by this project, shall be removed daily from the site and disposed of off-base by the CONTRACTOR.

B. Off-base disposal of materials shall be in conformance with applicable Federal, state, and local pollution regulations at the CONTRACTOR's expense.

1.15 PROTECTION OF BUILDING CONTENTS

A. The CONTRACTOR shall protect from damage all building contents located immediately adjacent to the site of work, and shall repair, replace, or otherwise be held liable for all such damage. Building contents include but are not limited to, furniture, equipment, materials, or items of supplies.

1.16 ACCOMPLISHMENT OF WORK

A. Access for delivery of materials and equipment, as well as removal of demolished equipment shall be coordinated with the COTR who will, in turn, coordinate with the 375 CES/CEO or CEV. Construction personnel entry and locations of construction delivery, debris removal, construction storage and trailers, construction parking and personnel entries will be provided by a 375 CES representative at the preconstruction meeting or to the COTR, as appropriate.

B. Base communications personnel shall be allowed to work periodically within the project area during the construction period installing operational communication lines.

C. Smoking will not be permitted within any area of any federal building.

1.17 RECYCLING

A. In support of national environmental efforts, the Contractor is encouraged to recycle general administrative refuse associated with this project. This refuse

includes cardboard, one gallon mark 1 and 2 plastic bottles, type 1 and 2 plastic soda bottles, aluminum and steel soda cans, and mixed paper. The Base Recycling Center, Building 3286, on South Drive will accept items Monday through Friday between the hours of 7:00 a.m. and 4:00 p.m. Submit Affirmative Procurement Plan, compliance with FAR 52.223-9 submit estimates of the percentage of recovered materials and FAR 52.223-4. Recovered material certification as found at www.epa.gov/cpg/products.htm.

1.18 COMMUNICATIONS COORDINATION REQUIREMENTS

A. CONTRACTOR shall, in order to effect the appropriate coordination and obtain clearance to operate two-way radio and radio frequency transmitting equipment on Scott AFB, contact the Frequency Management Office at 256-6464/2842, through the COTR.

1.19 SITE ACCESS AND SECURITY

A. United States Air Force Security has jurisdiction over all activities on or relevant to Scott Air Force Base. The CONTRACTOR, Subcontractors, Suppliers, and any other persons and organizations performing or furnishing any of the Work shall fully comply with any and all lawful orders of Air Force Security Staff.

B. All CONTRACTOR access to the Site shall only be via the Mascoutah Gate located at the south end of the Base off Illinois Hwy. 161. Entrance to the Site shall be restricted and require issuance of a security pass or badge subject to the requirements of Air Force Security. Provide on Contractor Letter Head referencing project title, location and contract number, Individual's Name and Driver's license number, Vehicle's Tag number and whether company or privately owned. Each vehicle must have available proof of insurance. Processing of request will take 48 hours after submission to COTR.

C. The following is information pertaining to law enforcement and security policies in effect at Scott Air Force Base. Questions or comments that concern the Security Police, must be directed to the Police Services Section at 256-5403 or 6-5403 on base, through the COTR.

1. Speed Limits: Speeding is not tolerated on Scott AFB. Speed should never exceed 30 mph. Radar detectors are illegal and speed limits are strongly enforced.
   a. 10 mph in all parking lots.
   b. 15 mph in Cardinal Creek Village housing area.
   c. 20 mph in all other housing areas.
   d. 30 mph on Scott AFB roadways unless otherwise posted.

2. Reserved/Prohibited Parking Areas:
   a. Reserved parking is marked by signs listing the person or category for whom the space is reserved or stating which type of decal is required to park in the space.
   b. Prohibited parking is marked by sign or yellow paint on the curb.
   c. Parking on the grass or seeded areas is strictly prohibited unless it is required for contract completion, in the contract area only.
3. Crosswalks: Motorists are required to yield to anyone in or about to enter a crosswalk.
4. Joggers/Cyclists: Motorists are cautioned to look out for high numbers of people engaged in exercise, especially during the middle of the day.
5. Traffic Citations: Violation of base traffic rules could affect CONTRACTOR or individual access to the base. All provisions of the Illinois Vehicle Code and Air Force Regulations are enforceable for all drivers on Scott AFB. Actions taken as result of traffic citations:
   a. Notification to employer with required actions.
   b. Loss of base driving privileges.
   c. Fines.
   d. Barment from the base.
6. Weapons: No firearms, plastic explosives, fireworks, or any object which fires a projectile or explosive can be brought on base (except approved construction equipment). Offenses of this nature will be referred to the St. Clair County Sheriffs Office, the U.S. Magistrates Court, or the Bureau of Alcohol, Tobacco and Firearms.
7. Gate Closures: Anytime a security system is activated or a hostile act is committed on base, security procedures call for access gates to be closed until the "all-clear" is given. Delays may occur when attempting to enter or depart the base during such an incident.
8. Controlled/Restricted Areas: Areas posted as Controlled or Restricted Areas (including the flightline, taxiways and ramps) are clearly marked with signs and constitute legal "No Trespassing" zones. Entry into these areas is strictly prohibited unless specific written authority is granted. Persons inadvertently entering a Controlled/Restricted area will be apprehended by security personnel and treated as hostile until proper identity can be confirmed. Personnel should cooperate with security personnel in these types of situations since security personnel will continue to elevate force with resistance received.
9. Required Coordination: If required to block off a street or portion of a street, before doing so, and with as much advance notice as possible, CONTRACTOR shall coordinate with the Security Police Operations Branch between 7:30 a.m. and 4:30 p.m., Monday through Friday, at 256-3674 through the COTR. Minimum 3 working days notice is required.
10. Base Entry: Display Air Force Form 75 (Vehicle Pass), issued from the Pass and Registration Office, in the front windshield on the lower left

side for easy viewing by security personnel. These passes are not interchangeable and must be accounted for at all times and turned in upon contract completion. Current vehicle registration, valid driver's license and vehicle insurance are mandatory when on Scott AFB.

D. CONTRACTOR shall ensure all pilferable items are secured when not in use.

E. For Further Guidance or Specifics:

1. Crime Stop: 256-1100 (24-hour operation).
2. Routine: 256-2223 (Law Enforcement Desk Sgt.) (24-hour operation).
3. Coordination: 256-3674 (Security Police Operations) (7:30 a.m. to 4:30 p.m.).
4. Pass and Registration: 256-2709.
5. General Inquiries: 256-5956 (Joint Use Office).
6. Emergencies: 911.

1.20 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are a part of this Specification.

1. CONTRACTOR Hazardous Material Identification Form.
2. CONTRACTOR HM Identification Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

CONTRACTOR HAZARDOUS MATERIAL IDENTIFICATION FORM

Part I

This part is to be completed by CONTRACTOR prior to start date and shall be maintained on the jobsite.

CONTRACTOR Company: _____

Proposed Work Term: _____ to _____

CONTRACTOR Point of Contact: _____

Phone Number: _____

HM to be Used: Mfg./Product	MSDS Attached	Quantity Used	Disposal Procedures	Used/Unused Material Removed from ANG Installation

Note: This form is good for a 1 month period and is to be submitted to the hazardous material pharmacy (HMP). All HM (hazardous material) used thereafter will be identified to CONTRACTING OFFICER's Representative for approval by the HMP. See Part II for CONTRACTOR closeout procedures. HMP contact is Sean Matthews (775) 788-4558.

HMP Approval Signatures: _____

BEE (Bio Environmental Engineer/Tech): _____

BEEO (Bio Environmental Engineering Office): _____

ENV (Environmental Manager): _____

Safety Officer: _____

CONTRACTOR HM IDENTIFICATION FORM
(Closeout Procedures)

Part II

Attach this part to Part I.

The CONTRACTOR shall accompany the Environmental Manager on the closeout inspection to ensure all used/unused HM was removed from the installation.

Closeout Signatures: _____ Date _____

ENV (Environmental Manager): _____

CONTRACTING OFFICER's Representative: _____

CONTRACTOR: _____

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section describes the project and the work to be performed under the Contract. Detailed requirements and the extent of work are stated in the applicable specification sections and shown on the Drawings. Cost Options are also described herein.

1.2 ORGANIZATION AND INTERPRETATION OF CONTRACT DOCUMENTS

A. Specifications and Drawings included in these Contract Documents establish the performance, quality requirements, location, and general arrangement of materials and equipment, and establish the minimum standards for quality of workmanship and appearance.

B. Piping work shown on the Drawings is intended to be depictive and may not be an exact and complete representation of the actual finished work. Include fittings, joints, supports, nut, bolts, and other accessories required to provide complete and satisfactory piping systems, as specified, even though some items may not be specifically shown on the Drawings.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The completed Base Bid Work will provide the GOVERNMENT with building construction and associated sitework as shown.

B. The Base Bid Work includes, but is not limited to, the following elements:

1. Relocation of communication and electrical lines.
2. Demolition and removal of abandoned storm drain, concrete curb and gutter, and miscellaneous items, except for site demolition by GOVERNMENT noted on Drawing C-1.
3. Modification to the Existing Flight Simulator Training Facility for new building.
4. Site grading to bring areas between buildings and parking lots or roads to finish grade including adjustments to grade, replacing uncontrolled fill with structural fill topsoil placement and finish grading.
5. Construction of utility connections.
6. Construction of building service areas.
7. Paving, excluding sidewalks and exterior break area.
8. Base Bid shall exclude seeding and landscaping.

9. Construction of building, except as noted below:
   a. Base Bid excludes Operable Partitions, Overhead Projection Screens and Lockers.

C. The following are Optional Bid Items for the project:

1. Option 1—Provide unglazed porcelain stoneware floor tile (UPST) flooring for Corridors 107 and 108 in lieu of VCT.
2. Option 2—Provide seeding, landscape plantings including shade trees, ornamental trees, evergreen trees, large and small shrubs, perennials and ornamental grasses and ground cover, shown on Drawings C-2, and concrete sidewalks.
3. Option 4-Provide Operable Partitions, Overhead Projection Screens and Lockers.

PART 2 PRODUCTS (NOT USED)

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 ADMINISTRATIVE SUBMITTALS

A. Schedule of Values: Submit schedule on AIA Document G703.

B. Schedule of Estimated Progress Payments: Submit with initially approved Schedule of Values.

C. Application for Payment.

D. Final Application for Payment.

1.2 SCHEDULE OF VALUES

A. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.

B. Lump Sum Work:

1. List Bonds and insurance premiums, mobilization, demobilization, facility startup, and contract closeout separately.
2. Break down by Division 1 through 16 with appropriate subdivision of each Specification and subcontractors for each.

C. An unbalanced or front-end loaded schedule will not be acceptable.

D. Summation of the complete Schedule of Values representing all Work shall equal the Contract Price. No more than 5 percent of the work (as measured by the Schedule of Values) shall be scheduled in the last 10 percent of the contract performance period.

E. Submit schedule of values on 3.5-inch, 1.44 mb diskettes, in a spreadsheet format compatible with the latest version of Excel.

1.3 APPLICATION FOR PAYMENT

A. Refer to FAR 52.232-5, “Payments Under Fixed Price Construction Contracts.”

B. Use AIA Document G702.

1.4 MEASUREMENT—GENERAL

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, the material shall be weighed on scales furnished by CONTRACTOR and certified accurate by the state agency responsible. A weight or load slip shall be obtained from the weigher and delivered to the COTR at the point of delivery of the material.

C. If material is shipped by rail, the car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by COTR/CM. Each vehicle shall bear a plainly legible identification mark.

E. All materials which are specified for measurement by the cubic yard measured in the vehicle shall be hauled in vehicles of such type and size that the actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. All vehicles shall be loaded to at least their water level capacity. Loads hauled in vehicles not meeting the above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

F. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

G. Units of measure shown on the Bid Form shall be as follows unless specified otherwise.

Item	Method of Measurement
AC	Acre—Field Measure by COTR/CM
CY	Cubic Yard—Field Measure by COTR/CM within the limits specified or shown

Item	Method of Measurement
CY-VM	Cubic Yard—Measured in the Vehicle by Volume
EA	Each—Field Count by COTR/CM
GAL	Gallon—Field Measure by COTR/CM
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure by COTR/CM
LS	Lump Sum—Unit is one; no measurement will be made
SF	Square Foot
SY	Square Yard
TON	Ton—Weight Measure by Scale (2,000 pounds)

1.5 PAYMENT

A. General:

1. Progress payments will be made monthly.
2. The date for CONTRACTOR's submission of monthly Application for Payment shall be established at the Preconstruction Conference.

B. Payment shall be made according to the items shown and CONTRACTOR pricing provided on the conformed Bid Form. Items on the conformed Bid Form consist of a combination of lump sum and unit price items. Descriptions of the items are:

1. Lump Sum Items:

Item	**Description**
Base Bid	Includes all demolition, sitework, landscaping work, building construction, and all other work not included in the other bid items.

1.6 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.

3. Rejected loads of material, including material rejected after it has been placed by reason of failure of CONTRACTOR to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Material delivered but not installed.
6. *Defective* Work not accepted by Contracting Officer.
7. Material remaining on hand after completion of Work.

1.7 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Refer to FAR 52.232-5, "Payments Under Fixed Price Construction Contracts."

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01040
COORDINATION

PART 1 GENERAL

1.1 ADMINISTRATIVE SUBMITTALS

A. Statement of Qualification (SOQ) for land surveyor or civil engineer.

B. Photographs and other records of examination.

1.2 REFERENCE DOCUMENTS

A. The following document is available for review and/or purchase from the Contracting Officer:

1. Site Investigation Report for the 126 ARW Flight Simulator Facility, Scott AFB, Illinois, dated June 1999, prepared by Hanson Engineers, Inc. This is the geotechnical engineering report for the specific facility indicated.

1.3 OTHER WORK

A. Coordination of GOVERNMENT's Work by Others: Reference other parts of the Contract Documents for coordination of GOVERNMENT's work by others, if any, and coordinate CONTRACTOR's Work with GOVERNMENT COTR. Refer to Section SUMMARY OF WORK and notes on Drawing C-1.

B. Public Utilities and Agencies: Coordinate Utilities through COTR for scheduling.

1. Gas:
   a. Agency and Contact Person:
      Illinois Power
      1050 West Boulevard
      PO Box 428
      Belleville, IL 62222-0428
      Mr. Gary Sheerin
      618 - 236-6271
   b. Work to be performed by Illinois Power includes design and construction of gas line abandonment, new mains and new building services for the facility.
   c. Work to be performed by Illinois Power shall be scheduled by 126 ARW.

2. Scott AFB:
   a. Agency and Contact Person:
      375 Airlift Wing (AW)
      701 Hangar Rd.
      Scott AFB, IL 62225
      Mr. John Patterson
      375 AW/CE Chief of Planning and Programming
      618 - 256-4764.

1.4 UTILITIES/INFRASTRUCTURE

A. Coordinate Work through COTR with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.

1. Power: Scott AFB:
   a. Contact Person: Mr. Fred Krems, 375 CES/CEOI.
   b. Telephone: 618-256-4973.
2. Gas: Illinois Power:
   a. Contact Person: Mr. Gary Sheerin.
   b. Telephone: 618-236-6271.
3. Telephone: Ameritech:
   a. Contact Person: MSG Michael Nowak
   b. Telephone: 618-222-5808.
4. Cable Television: TCI:
   a. Contact Person: MSG Michael Nowak
   b. Telephone: 618-222-5808.
5. Domestic Water: Scott AFB:
   a. Contact Person: Mr. Bill Micka, 375 CW/CECD.
   b. Telephone: 618-256-4766.
6. Sanitary Sewer: Scott AFB:
   a. Contact Person: Mr. Bill Micka, 375 CW/CECD.
   b. Telephone: 618-256-4766.
7. Storm Sewer System: Scott AFB:
   a. Contact Person: Mr. Paul Schmidt, 375 CES/CED.
   b. Telephone: 618-256-4823.
8. Military Communications System:
   a. Contact Person: Mr. Richard Zienda, 375 CS/SCX.
   b. Telephone: 618-576-3436.
9. Scott AFB Roadways:
   a. Contact Person: Mr. Bill Micka, 375 CW/CECD.
   b. Telephone: 618-256-4766.

1.5 PROJECT MEETINGS

A. General:

1. COTR/CM: Schedule physical arrangements for meetings throughout progress of Work, prepare meeting agenda with GOVERNMENT and CONTRACTOR input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 3 days after each meeting to participants and parties affected by meeting decisions.
2. Representatives of GOVERNMENT, CONTRACTOR, and Subcontractors shall attend meetings, as needed.

B. Preconstruction Conference:

1. CONTRACTOR shall be prepared to discuss the following subjects, as a minimum:
   a. Required schedules.
   b. Status of Bonds and insurance.
   c. Sequencing of critical path work items.
   d. Project changes and clarification procedures (requests for Information, or RFI's).
   e. Use of site, access, office and storage areas, security and temporary facilities.
   f. Major product delivery and priorities.
   g. CONTRACTOR's safety plan and representative.
   h. Progress payment procedures.
2. Attendees may include but not be limited to:
   a. GOVERNMENT's representatives.
   b. Scott AFB representatives.
   c. COTR/CM.
   d. COTR/CM's representatives.
   e. Utility representatives and others as appropriate.
3. Required Attendees include:
   a. CONTRACTOR's resident superintendent.
   b. CONTRACTOR's quality control representative.
   c. Subcontractors' representatives whom CONTRACTOR may desire or COTR/CM may request to attend.

C. Progress Meetings:

1. COTR/CM will schedule regular progress meetings at site, conducted weekly to review Work progress, progress schedule, Shop Drawing and Sample submissions schedule, Application for Payment, contract modifications, and other matters needing discussion and resolution.

2. Attendees will include:
   a. GOVERNMENT's representative(s), as appropriate.
   b. Scott AFB representatives.
   c. CONTRACTOR, Subcontractors, and Suppliers, as appropriate.
   d. COTR/CM's representative(s).
   e. Utility representatives and others as appropriate.

D. Other Meetings: In accordance with Contract Documents and as may be required by GOVERNMENT and COTR/CM.

1.6 SEQUENCE OF WORK

A. Include the Milestones and sequences of Work specified herein as a part of the progress schedule required under Section 01310, PROGRESS SCHEDULES.

B. Be responsible for bypass facilities and temporary connections required to maintain GOVERNMENT's operations. Site demolition (NIC) will take place prior to the CONTRACTOR commencing with the specified work. Site demolition will be performed by the GOVERNMENT and will include removal of existing parking lot pavement and backfilling all clean fill.

C. Utility service interruptions shall be addressed in accordance with Section 01001, GENERAL REQUIREMENTS, and the following:

1. Describe the reason, anticipated length of time, and areas affected by any proposed utility outage in a written request to the COTR/CM. Provide temporary provisions for continuous power supply to critical existing facility components if requested.
2. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of GOVERNMENT's operations.
3. Coordinate proposed Work with the COTR/CM and facility operations personnel before effecting unit shutdowns. Under no circumstances cease Work at the end of a normal working day if such actions may inadvertently cause a cessation of any facility operating process, in which case, remain onsite until necessary repairs are complete.
4. Do not close lines, open valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after approval of GOVERNMENT and COTR. Such actions will be considered by GOVERNMENT and COTR upon 48 hours written notice to COTR.

1.7 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at site is started, CONTRACTOR, COTR/CM, and Scott AFB personnel shall make thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which might be damaged by construction operations. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.
2. Record observations for signature of COTR/CM and CONTRACTOR.

B. Documentation:

1. All photography shall be taken with a digital camera:
   a. The CONTRACTOR shall be required to photographically document all phases of the project including pre-construction, construction, and post-construction site conditions and progress. Project photographs shall be taken on a weekly basis beginning immediately after Notice to Proceed (NTP), in advance of construction activities, and continuing throughout the project until final acceptance has been formerly obtained from the Contracting Officer.
   b. Weekly photographs shall be taken utilizing digital technology. A minimum of fifteen (15) color exposures shall be taken weekly, ensuring that every aspect of the site and adjacent properties as well as the interior and exterior of all new or impacted structures is documented. The COTR/CM reserves the right to select the locations and/or vantage points from which the photographs will be taken as well as the actual content of the photographs. A minimum of four (4) photographs shall be taken from the identical vantage point and same direction each interval to facilitate a time motion sequence, as coordinated by the COTR/CM.
   c. Digital photographs shall have a minimum resolution of 1152 × 864 pixels and 24 bit, millions of colors as produced by a Kodak DC210 or DC120 Zoom camera or equivalent. Digital images shall be archived utilizing the Watermark Photo Management System, current version, or approved equal.
   d. All project photographs shall be labeled with the following information:
      1) Project name
      2) Date and time photo was taken
      3) Photographer's name
      4) Caption (30 characters max)

5) Description
6) Location and/or area designation
7) Schedule activity number as appropriate

e. Digital images shall be annotated within the Watermark software. Digital images shall be delivered in Watermark export packages on compact disc(s) which are individually labeled with the project/ owner's name week and year images were produced, and contract number.

f. All photographs shall be delivered to the COTR/CM office within five business days of being taken.

2. Submit two copies of photographs or other records documenting examination for COTR/CM's signature. COTR/CM will review, sign, and return one record copy of every observation document and photograph to CONTRACTOR to be kept on file in CONTRACTOR's field office as site records.
3. These observations and photographs are intended for use as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of CONTRACTOR's operations, and are for protection of adjacent property owners, CONTRACTOR, and GOVERNMENT.

1.8 SCOTT AFB FACILITIES

A. Comply with Section 01001, GENERAL REQUIREMENTS.

B. Operation of Existing Facilities:

1. Continuous operation of existing Scott AFB facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.
2. Conduct Work outside regular working hours only on prior written consent of COTR/CM to meet Project schedule and avoid undesirable conditions.
3. Do not proceed with Work affecting a facility's operation without obtaining COTR/CM's advance approval of the need for and duration of such Work.

C. Relocation of Existing Facilities:

1. During construction, it is expected that minor relocations of Work will be necessary.
2. Provide complete relocation of existing structures and underground facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.

5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by COTR/CM.

1.9 PHYSICAL CONDITIONS

A. Exercise reasonable care to verify locations of existing subsurface structures and underground facilities.

B. Thoroughly check immediate and adjacent areas subject to excavation by visual examination (and by electronic metal and pipe detection equipment, as necessary) for indications of subsurface structures and underground facilities.

C. Make exploratory excavations where existing underground facilities or structures may potentially conflict with proposed underground facilities or structures. Conduct exploratory excavations in presence of COTR/CM and sufficiently ahead of construction to avoid possible delays to CONTRACTOR's Work.

1.10 REFERENCE POINTS AND SURVEYS

A. Location of new building shall be off existing Flight Simulator Training Facility.

B. Elevation of first floor of new building shall match existing Flight Simulator Training Facility.

C. CONTRACTOR shall perform specific construction layout.

D. Dimensions for lines and elevations for grades of structures, appurtenances, and utilities are indicated on Drawings, together with other pertinent information required for laying out Work. If conditions vary from those indicated, notify COTR/CM immediately, who will make minor adjustments required.

E. COTR/CM may perform checks to verify accuracy of CONTRACTOR's layout Work and that completed Work complies with Contract Documents.

F. Any existing survey points or other control markers destroyed without proper authorization will be replaced by owner of the survey points or control markers at the CONTRACTOR's expense.

G. CONTRACTOR's Responsibilities:

1. Provide additional survey and layout required.
2. Locate and protect reference points prior to starting site preparation.

3. Notify COTR/CM at least 3 working days in advance of time when grade and line to be provided by others will be needed.
4. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
5. In event of discrepancy in data or staking provided by COTR/CM, request clarification before proceeding with Work.
6. Preserve and leave undisturbed control staking until COTR/CM has completed checks it deems necessary.
7. Re-establish reference points resulting from destruction by CONTRACTOR's operations.
8. Retain professional land surveyor or civil engineer registered in state of Illinois who shall perform or supervise engineering surveying necessary for additional construction staking and layout.
9. Maintain complete accurate log of survey Work as it progresses as a Record Document.
10. On request of COTR/CM, submit documentation.
11. Provide competent employee(s), tools, stakes, and other equipment and materials as COTR/CM may require to check layout, survey, and measurement Work performed by others.
12. Cooperate with COTR/CM so that checking and measuring may be accomplished with least interference to CONTRACTOR's operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill and paving or other final surfacing elements as required, to make Work complete.

B. Obtain prior written authorization of COTR/CM before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, or any structural member.
2. Weather- or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and Work is evident in finished surfaces.

D. Restore existing work, underground facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use best recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by CO.

END OF SECTION

SECTION 01092
ABBREVIATIONS

PART 1 GENERAL

1.1 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in the Contract Clauses, and as may otherwise be required herein and in the individual Specification sections.

B. Work specified by reference to the published standard or specification of a government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet the requirements or surpass the minimum standards of quality for materials and workmanship established by the designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed the additional prescriptive or performance requirements included within the Contract Documents to establish a higher or more stringent standard of quality than that required by the referenced standard.

D. Where two or more standards are specified to establish quality, the product and workmanship shall meet or exceed the requirements of the most stringent.

E. Where both a standard and a brand name are specified for a product in the Contract Documents, the proprietary product named shall meet or exceed the requirements of the specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by the CONTRACTOR, obtain a copy or copies directly from the publication source and maintain in an orderly manner at the site as Work site records, available to the CONTRACTOR's personnel, Subcontractors, Contracting Officer, and COTR/CM.

1.2 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ACI	American Concrete Institute
6.	AFBMA	Anti-Friction Bearing Manufacturers' Association
7.	AGA	American Gas Association
8.	AGMA	American Gear Manufacturers' Association
9.	AI	Asphalt Institute
10.	AISC	American Institute of Steel Construction
11.	AISI	American Iron and Steel Institute
12.	AITC	American Institute of Timber Construction
13.	ALS	American Lumber Standards
14.	AMA	Acoustical Materials Association
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	American Plywood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AREA	American Railway Engineering Association
21.	ARI	Air Conditioning and Refrigeration Institute
22.	ASA	American Standards Association
23.	ASAE	American Society of Agricultural Engineers
24.	ASCE	American Society of Civil Engineers
25.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
26.	ASNT	American Society for Nondestructive Testing
27.	ASME	American Society of Mechanical Engineers
28.	ASTM	American Society for Testing and Materials
29.	AWI	Architectural Wood Work Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPB	American Wood Preservers Bureau
32.	AWPI	American Wood Preservers' Institute
33.	AWS	American Welding Society
34.	AWWA	American Water Works Association
35.	BHMA	Builders Hardware Manufacturers' Association

36.	CBMA	Certified Ballast Manufacturers' Association
37.	CDA	Copper Development Association
38.	CES/CEO	Civil Engineering Squadron/Operations
39.	CGA	Compressed Gas Association
40.	CIPRI	Cast Iron Pipe Research Institute
41.	CISPI	Cast Iron Soil Pipe Institute
42.	CM	Construction Manager (CH2M Hill)
43.	CMAA	Crane Manufacturers' Association of America
44.	CO	Contracting Officer
45.	COTR or COTR/CM	Contracting Officer's Technical Representative/Construction Manager (on behalf of CO)
46.	CRSI	Concrete Reinforcing Steel Institute
47.	CS	Commercial Standard
48.	CSA	Canadian Standards Association
49.	CSI	Construction Specifications Institute
50.	CTSS	Caltrans Standard Specification
51.	EJCDC	Engineers Joint Contract Documents' Committee
52.	ETL	Engineering Test Laboratories
53.	FCC	Federal Communications Commission
54.	FEMA	Federal Emergency Management Agency
55.	FGMA	Flat Glass Marketing Association
56.	FM	Factory Mutual
57.	Fed. Spec.	Federal Specifications
58.	FS	Federal Specification
59.	GA	Gypsum Association
60.	HI	Hydraulic Institute
61.	HMI	Hoist Manufacturers' Institute
62.	ICBO	International Conference of Building Officials
63.	ICEA	Insulated Cable Engineers' Association
64.	IDOT	Illinois Department of Transportation
65.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
66.	IEPA	Illinois Environmental Protection Agency
67.	IES	Illuminating Engineering Society
68.	IFI	Industrial Fasteners Institute
69.	ISA	Instrument Society of America
70.	ISO	Insurance Service Office
71.	JIB	Joint Industry Conferences of Hydraulic Manufacturers
72.	MIA	Marble Institute of America
73.	Mil. Sp. or MIL	Military Specification
74.	MS	Military Specifications

75.	MMA	Monorail Manufacturers' Association
76.	NAAMM	National Association of Architectural Metal Manufacturers
77.	NACE	National Association of Corrosion Engineers
78.	NBHA	National Builders' Hardware Association
79.	NEC	National Electrical Code
80.	NECA	National Electrical Contractor's Association
81.	NEMA	National Electrical Manufacturers' Association
82.	NESC	National Electric Safety Code
83.	NFPA	National Fire Protection Association
84.	NHLA	National Hardwood Lumber Association
85.	NHPMA	Northern Hardwood and Pine Manufacturer's Association
86.	NLMA	National Lumber Manufacturers' Association
87.	NRCA	National Roofing Contractors Association
88.	NSF	National Sanitation Foundation Testing Laboratory
89.	NSPE	National Society of Professional Engineers
90.	NTMA	National Terrazzo and Mosaic Association
91.	NWWDA	National Wood Window and Door Association
92.	OECI	Overhead Electrical Crane Institute
93.	OSHA	Occupational Safety and Health Act (both Federal and State)
94.	OWNER	Government
95.	PCI	Prestressed Concrete Institute
96.	PEI	Porcelain Enamel Institute
97.	PPI	Plastic Pipe Institute
98.	PS	Product Standards Section-U.S. Department of Commerce
99.	RMA	Rubber Manufacturers' Association
100.	SAE	Society of Automotive Engineers
101.	SCPRF	Structural Clay Products Research Foundation
102.	SDI	Steel Deck Institute
103.	SDI	Steel Door Institute
104.	SIGMA	Sealed Insulating Glass Manufacturing Association
105.	SJI	Steel Joist Institute
106.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
107.	SPI	Society of the Plastics Industry
108.	SSPC	Steel Structures Painting Council
109.	SWI	Steel Window Institute
110.	TEMA	Tubular Exchanger Manufacturers' Association
111.	TCA	Tile Council of America

112.	UBC	Uniform Building Code
113.	UFC	Uniform Fire Code
114.	UL	Underwriters Laboratories Inc.
115.	UMC	Uniform Mechanical Code
116.	US	U.S. Bureau of Standards
117.	USBR	U.S. Bureau of Reclamation
118.	WCLIB	West Coast Lumber Inspection Bureau
119.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.1 GENERAL

A. Inquiries: Direct to COTR or Contracting Officer regarding procedure, purpose, or extent of Submittal.

B. Timeliness: Schedule and make submissions in accordance with requirements of individual Specification sections and in such sequence as to cause no delay in Work or in work of other contractors.

C. Identification of Submittals:

1. Complete, sign, and transmit with each Submittal package, one transmittal of AF Form 3000 attached at the end of this section.
2. Identify each Submittal with the following numbering and tracking system:
   a. Sequentially number each Submittal.
   b. Resubmission of a Submittal will have original number with sequential numeric decimal suffix.
3. Format: Orderly, indexed with labeled tab dividers.
4. Show date of submission.
5. Show Project title and Contracting Officer's contract identification and contract number.
6. Show names of CONTRACTOR, Subcontractor or Supplier, and manufacturer as appropriate.
7. Identify, as applicable, Contract Document section and paragraph to which Submittal applies.
8. Identify Submittal type; submit only one type in each Submittal package.
9. Identify and indicate each deviation or variation from Contract Documents.

D. Resubmissions: Clearly identify each correction or change made.

E. Incomplete Submittal Submissions:

1. Contracting Officer will return the entire Submittal for CONTRACTOR's revision/correction and resubmission.

2. Submittals which do not clearly bear CONTRACTOR's specific written indication of CONTRACTOR review and approval of Submittal or which are transmitted with an unsigned or uncertified submission form or as may otherwise be required will be returned to CONTRACTOR without review.

F. COTR/CM's Review: COTR/CM will act upon CONTRACTOR's Submittal and transmit response to CONTRACTOR not later than 30 days after receipt, unless otherwise specified. Resubmittals will be subject to the same review time.

G. Schedule Delays:

1. No adjustment of Contract Times or Price will be allowed due to COTR/CM's review of Submittals, unless all of the following criteria are met:
   a. CONTRACTOR has notified Contracting Officer/COTR/CM in writing that timely review of Submittal in question is critical to progress of Work, and has received Contracting Officer/COTR/CM's written acceptance to reflect such on current accepted submissions and progress schedule. Written agreement by the Contracting Officer/COTR/CM to reduce Submittal review time will be made only for unusual and CONTRACTOR justified reasons. Acceptance of a progress schedule containing Submittal review times less than specified or less than agreed to in writing by Contracting Officer/COTR/CM will not constitute Contracting Officer/COTR/CM's acceptance of the review times.
   b. Contracting Officer/COTR/CM has failed to review and return first submission of a Submittal within agreed time indicated on current accepted schedule of submissions.
   c. CONTRACTOR demonstrates that delay in progress of Work is directly attributable to Contracting Officer/COTR/CM's failure to return Submittal within time indicated and accepted by Contracting Officer/COTR/CM.
2. No adjustment of Contract Times or Price will be allowed due to delays in progress of Work caused by rejection and subsequent resubmission of Submittals, including multiple resubmissions.

1.2 SHOP DRAWINGS AND SAMPLES

A. Copies:

1. Shop Drawings and Product Data: Six.
2. Samples: Two, unless otherwise specified in individual Specification sections.

B. General: Submit to COTR/CM as required by individual Specification sections.

C. Identify and Indicate:

1. Pertinent Drawing sheet(s) and detail number(s), products, units and assemblies, and system or equipment identification or tag numbers.
2. Critical field dimensions and relationships to other critical features of Work.
3. Samples: Source, location, date taken, and by whom.
4. Each deviation or variation from Contract Documents.

D. Design Data: When specified, provide Project-specific information as required and as necessary to clearly show calculations, dimensions, logic and assumptions, and referenced standards and codes upon which design is based.

E. Foreign Manufacturers: When proposed, include following additional information:

1. Names and addresses of at least two companies closest to Project that maintain technical service representatives.
2. Complete inventory of spare parts and accessories for each piece of equipment.

F. Preparation:

1. Format: Whenever possible, schedule for and combine Shop Drawings and Samples required for submission in each Specification section or division into a single Submittal package. Also combine product data for like items into a single Submittal package.
2. Present in a clear and thorough manner and of sufficient detail to show kind, size, arrangement, and function of components, materials, and devices and compliance with Contract Documents. Identify details by reference to sheet and detail, and schedule or room numbers shown on Drawings.
3. Reproducible Copy:
   a. Preferred Minimum Sheet Size: 8-1/2- by 11-inch and 11- by 17-inch pages, suitable for photocopying.
   b. Larger than 11- by 17-Inch Sheets: 22-inch by 34-inch blue lines or photo copies, suitable.
4. Piping Systems: Drawn to scale.
5. Product Data: Clearly mark each copy to identify pertinent products or models and show performance characteristics and capacities, dimensions and clearances required, wiring or piping diagrams and controls, and external connections, anchorages, and supports required.

6. Equipment and Component Titles: Identical to title shown on Drawings.
7. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to Work.
   b. Supplement standard information to provide information specifically applicable to Work.

G. Shop Drawing Disposition: COTR will review, mark, stamp as appropriate, and forward marked-up copies to the Contracting Officer. Copies of shop drawings will be distributed according to the disposition rendered:

1. Approved as Submitted (for incorporation in Work):
   a. One copy—Contracting Officer.
   b. One copy—COTR.
   c. Two copies—CM's files (field and submittal reviewing office files).
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR may begin to implement activities to incorporate specific product(s) or Work covered by Submittal.
2. Approved as Noted (for incorporation in Work):
   a. One copy—Contracting Officer.
   b. One copy—COTR.
   c. Two copies—CM's files (field and submittal reviewing office files).
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR may begin to implement activities to incorporate product(s) or Work covered by Submittal, in accordance with COTR/CM's notations.
3. Disapproved:
   a. One copy—Contracting Officer.
   b. One copy—COTR.
   c. Two copies—CM's files (field and submittal reviewing office files).
   d. Remaining copies returned to CONTRACTOR appropriately annotated.
   e. CONTRACTOR shall make corrections or develop replacement and resubmit (in same manner and quantity as specified for original submission).
   f. Submittal is not approved.

H. Sample Disposition: Same as Shop Drawing disposition; samples will not be returned.

1.3 ADMINISTRATIVE SUBMITTALS

A. Copies: Submit four, unless specified otherwise.

B. Description: Submittals that are not Shop Drawings or Samples, or that do not reflect quality of product or method of construction. May include, but not limited to those Submittals identified below.

C. Applications for Payment (and Cash Allowance Data and Values): Meet requirements of Section 01025, MEASUREMENT AND PAYMENT.

D. Construction Photographs: In accordance with Section 01040, COORDINATION, and as may otherwise be required in the Contract Documents.

E. Progress Reports and Quantity Charts: As may be required in Section 01310, PROGRESS SCHEDULES.

F. Schedules:

1. Progress Schedule(s): Meet the requirements of Section 01310, PROGRESS SCHEDULES.
2. Schedule of Values: Meet requirements of Section 01025, MEASUREMENT AND PAYMENT.
3. Schedule of Submittal Submissions:
   a. Submit AF Form 66, Schedule of Material Submittals, that is attached at the end of this section within 10 days following Notice to Proceed or otherwise requested by the COTR and approved in writing by the Contracting Officer.
   b. Include the following other required submissions:
      1) Training plans.
      2) Test procedures.
      3) Operation and maintenance manuals.
      4) Record documents.
      5) Specifically required certificates, warranties, and service agreements.
   c. Coordinate with progress schedule and prepare submissions to show for each Submittal, at a minimum, the following:
      1) Estimated submission date to COTR/CM.
      2) Specifically requested and clearly identified COTR/CM review time if shorter than that set forth herein, with justification for such request and critical dates Submittals will be needed from COTR/CM.

3) For the first 6-month period from the date the Notice To Proceed or following any update or adjustment of the submissions, the estimated submission date shall be week, month, and year; for submissions beyond 6-month time period, show closest month and year.

d. Submit to COTR/CM monthly (i) updated list of changes that have occurred, otherwise submit a written communication confirming existing list, and (ii) adjusted submissions reflecting submission activity planned for forthcoming 6-month time period and beyond. Coordinate with progress schedule updates.

G. Training Materials: Meet the requirements of Section 01640, MANUFACTURERS' SERVICES.

H. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to COTR/CM for Contracting Officer's records one copy of correspondence and transmittals (to include enclosures and attachments) between CONTRACTOR and governing agency.

I. Disposition: COTR/CM will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

1. Accepted:
   a. Schedules: Acceptance will indicate that schedules provide for the orderly progression of the Work to completion within any specified milestones and the Contract Times, but such acceptance will neither impose on COTR/CM responsibility for the sequencing, scheduling, or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility therefor.
   b. Acceptance of other Administrative Submittals will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
   c. CONTRACTOR may proceed to perform Submittal related Work.
   d. One copy furnished Contracting Officer.
   e. One copy furnished COTR.
   f. One copy retained in CM's file.
   g. Remaining copies returned to CONTRACTOR appropriately annotated.

2. Rejected as Noted:
   a. One copy retained in COTR/CM's file.
   b. Remaining copies returned to CONTRACTOR appropriately annotated with a disapproval letter from the Contracting Officer.
   c. CONTRACTOR shall revise/correct or develop replacement and resubmit.

1.4 QUALITY CONTROL SUBMITTALS

A. Certificates:

1. Manufacturer's Certificate of Compliance:
   a. When specified in individual Specification sections or where products are specified to a recognized standard or code, submit prior to shipment of product or material to the site.
   b. COTR/CM may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
   c. Signed by product manufacturer certifying that materials, manufacture, and product specified conforms to or exceeds specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certifications as appropriate.
   d. May reflect recent or previous test results on material or product, but must be acceptable to COTR/CM.
2. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in the individual Specification sections.
3. Manufacturer's Certificate of Proper Installation: As required in Section 01640, MANUFACTURERS' SERVICES.

B. Operation and Maintenance Manual: As required in Section 01430, OPERATION AND MAINTENANCE DATA.

C. Statements of Qualification: Evidence of qualification, certification, or registration. As required in these Contract Documents to verify qualifications of professional land surveyors, engineers, materials testing laboratories, specialty Subcontractors, trades, specialists, consultants, installers, and other professionals.

Tests required by Contract Documents to be performed by CONTRACTOR and that require test certificates be submitted to the COTR/CM for acceptance shall be made by an independent testing laboratory or agency licensed or certified in accordance with laws and regulations and applicable state and local statutes. In the event state license or certification is not required, testing laboratories or agencies shall meet the following applicable requirements:

1. "Recommended Requirements for Independent Laboratory Qualification," published by the American Council of Independent Laboratories.
2. Basic requirements of ASTM E329, "Standard of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction" as applicable.
3. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

D. Field Samples: Provide as required by individual Specifications and as may be required by COTR/CM during progress of Work.

E. Written Test Reports of Each Test and Inspection: As a minimum, include the following:

1. Date of test and date issued, Project title and number, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
2. Date and time of sampling or inspection and record of temperature and weather conditions.
3. Identification of product and Specification section, location of Sample, test or inspection in the Project, type of inspection or test with referenced standard or code, certified results of test.
4. Compliance with Contract Documents, and identifying corrective action necessary to bring materials and equipment into compliance.
5. Provide an interpretation of test results, when requested by COTR/CM.

F. Disposition: COTR/CM will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

1. Accepted:
   a. Acceptance will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
   b. CONTRACTOR may proceed to perform Submittal related Work.
   c. One copy furnished COTR.
   d. One Copy Furnished Contracting Officer.
   e. One copy retained in CM's file.

f. Remaining copies returned to CONTRACTOR appropriately annotated.

2. Rejected as Noted:
   a. One copy retained in Contracting Officer/COTR/CM's file.
   b. Remaining copies returned to CONTRACTOR appropriately annotated.
   c. CONTRACTOR shall revise/correct or develop replacement and resubmit.

1.5 CONTRACT CLOSEOUT SUBMITTALS

A. General: In accordance with Section 01700, CONTRACT CLOSEOUT.

B. Disposition: Contracting Officer/COTR/CM will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

1. Accepted:
   a. Acceptance will indicate that Submittal conforms to intent of Contract Documents as to form and substance.
   b. CONTRACTOR may proceed to perform Submittal related Work.
   c. One copy furnished Contracting Officer.
   d. One copy furnished COTR.
   e. One copy retained in CM's file.
   f. Remaining copies returned to CONTRACTOR appropriately annotated.
2. Rejected as Noted:
   a. One copy retained in Contracting Officer/COTR/CM's file.
   b. Remaining copies returned to CONTRACTOR appropriately annotated.
   c. CONTRACTOR shall revise/correct or develop replacement and resubmit.

1.6 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.

1. AF Form 66—Schedule of Material Submittals.
2. AF Form 3000a—Material Approval Submittal and AF Form 3000b—Comments to Form 3000a.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

CONTRACT PROGRESS REPORT

OMB NO. 9000-0058
Expires Mar 31, 1993

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project OMB No. 9000-0058, Washington DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to: SAF/AQCQ, Pentagon, Washington DC 20330-1000.

CONTRACTOR	ADDRESS

REPORT NO.	PERIOD COVERED FROM: TO:	PROJECT NO.	CONTRACT NO.	COMPLETION DATE

LINE NO.	WORK ELEMENT	% OF TOTAL JOB	% COMPLETED THIS PERIOD	% COMPLETED CUMULATIVE
	TOTAL			

REMARKS

At the Contracting Officer's discretion and according to the payments clause of the contract, the information provided on this form may be used for computing progress payments.

PROGRESS OR COMPLETION CERTIFICATE

I hereby certify that the contractor has satisfactorily completed the indicated percentage of the contract per contract specifications.

SUBMITTED BY OR FOR

☐ CONTRACTOR ☐ BASE CIVIL ENGINEER

TYPE OR PRINT NAME AND TITLE	SIGNATURE	DATE

REVIEWED BY OR FOR CONTRACTING OFFICER

TYPE OR PRINT NAME AND TITLE	SIGNATURE	DATE

AF FORM 3065, SEP 91 *(EF)* PREVIOUS EDITION IS OBSOLETE.

INSTRUCTIONS TO CONTRACTORS

1. Prepare three copies of AF Form 3064, in accordance with these instructions and submit to the contracting officer at the time stated in the contract or as established by the contracting officer.

2. Blocks 1, 2, and 3. Enter the contract number, starting date, and completion date as shown on the contract.

3. Block 8. Enter the title of the project as shown on the contract.

4. Block 9. Enter name and address of your firm. The three copies submitted to the contracting officer must be dated and signed by the contractor or an authorized representative of the firm.

5. Lines 1 through 16. Major elements of work (whether unit price or lump sum contract) such as excavation, concrete work, carpentry, engineering, installation of communication electronic facilities, etc., will be shown in Column B in logical sequence and in sufficient detail to identify the element.

6. The percentage of each listed work element to the complete job will be shown opposite each element in Column C. As an example, if 3 work elements are shown: excavation, concrete work, and backfill, and it is estimated that excavation is 50% of the total job, concrete 30%, and backfill 20%, these percentages will be shown opposite each element. The total must equal 100%.

7. Columns D through Q will be used to show planned periodic progress , as required by the contracting officer, during the period of the contract. Only the top half of the space under these columns will be used by contractors. Using the example cited above and assuming that the contract period for performance is 8 weeks, and it is planned to accomplish 10% of the excavation work the 1st week and 20% each week until excavation is complete, 10 would be shown in the upper half of Line 1 under Column D, 20 under Column E, and 20 under Column F for a total of 50%. If it is planned to accomplish the concrete work during the 4th, 5th, and 6th weeks in equal amounts, 10 would be entered under Columns G, H, and I on Line 2. Assuming the backfill will be accomplished during the 7th and 8th weeks, 10 would be entered under Columns J and K on Line 3. If the contract extends beyond 14 weeks, additional copies of AF Form 3064, with appropriate alterations, may be spliced on as a continuation of performance record.

8. Total amount of work planned at intervals as shown in Columns D through Q will be totaled and entered in the top half of the space under the appropriate column on Line 16. Again using the example cited above, the totals under Columns D through K would read 10, 20, 20, 10, 10, 10, 10, 10, for a total of 100%. These totals will be used to plot an overlay graph using Lines 6 through Line 15, beginning with Columns D and extending to the right that number of columns (weeks) authorized by the contract for performance time.

9. Beginning at the lower left corner, Line 15, Column D, the graph will be plotted using a broken or dotted line showing the cumulative total progress for planned intervals. Again using the example cited above, the dotted line would, for the 1st week, extend from Line 15 to Line 14 under Column D for 10%. The second week the dotted line would extend from Line 14 to Line 12 under Column E for 20%, making a cumulative total of 30%. The dotted line should end (100%) at the intersection of Line 5 and Column K.

10. In the event the contract is modified by the contracting officer under terms of the contract, changing the progress of work as originally scheduled, adding or deleting work or changing the original completion date, a revised progress schedule will be prepared and submitted to the contracting officer for approval. In preparing the revised schedule, the amount of work completed will be considered, together with the changed new completion date set forth in the contract modification. Considering these factors, the work under the contract will be rescheduled over the new total performance time in the same manner that the original schedule was prepared. The new completion date will be entered in Block 3. "First Revised Schedule," "Second Revised Schedule," etc., will be entered immediately underneath the form title. Time of submission of the revised schedule will be determined by the contracting officer.

11. At such intervals as may be established by the contracting officer, the contractor will submit to the contracting officer. AF Form 3065. "Contract Progress Report," indicating the percentage of work accomplished for each work element during the established reporting period. Accurate reports are of the utmost importance to the contractor and to the Government, since the percentage of completion, or progress, thus reported is used in administration of the contract and may be used in connection with approval of partial payments under the contract. Care should be taken to plan the work in such manner that it can be accomplished as stated in this schedule. If for any reason it becomes known that any part of the progress under this contract will be delayed, this fact should be reported to the contracting officer immediately.

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SECTION 01310
PROGRESS SCHEDULES

PART 1 GENERAL

1.1 SUBMITTALS

A. Two separate types of progress schedule submittals shall be provided by the CONTRACTOR throughout the Contract duration:

1. Bi-weekly Progress Schedule and Report.
2. Monthly Progress Schedule and Report.

B. Submit with Each Progress Schedule Submission:

1. CONTRACTOR's certification that progress schedule submission is the actual schedule being utilized for execution of the Work.
2. Three Legible Copies of the Progress Schedule and electronic files on diskette for each computer generated schedule submission.
3. Disk file compatible with Primavera SureTrak.

1.2 BI-WEEKLY PROGRESS SCHEDULE AND REPORT

A. CONTRACTOR shall provide all information included on AF Form 3064 using Primavera SureTrak, or approved equal in a similar format shown on AF Form 3064. A copy of the form is attached at the end of this section. Contract Progress Schedule for that project, using the instructions on reverse of the form. This requirement is included to assure adequate planning and execution of work and to assist the Contracting Officer in appraising the reasonableness of the schedule and evaluating progress of the work.

B. Submit initial progress schedule (original, three copies, and a diskette) within 5 days after date of Notice to Proceed for COTR review and Contracting Officer approval.

C. The work shall be scheduled so that, upon the start of construction, work progresses in a continuous and diligent manner. A schedule which does not reflect steady and reasonable progress throughout the construction period will be rejected. No less than 30 percent of the required work shall be scheduled to be complete in the first half of the construction period, and not more than 5 percent of the required work shall be scheduled to be completed within the last 10 percent of the construction period.

D. Revise progress schedule as required and directed by the Contracting Officer.

E. Submit bi-weekly progress reports in accordance with paragraph 1.2.A herein.

1. Progress reports are required of both the CONTRACTOR and the COTR covering the period from Notice to Proceed through final inspection.
2. CONTRACTOR shall submit progress reports on the 15th day and on the last day of each month for those 2-week periods. The Contractor's Application for Payment (AIA Form G702 with continuation sheet) should be provided with the end of monthly progress report. (See appropriate sections of Contract Documents concerning Application for Payment requirements.)

1.3 MONTHLY PROGRESS SCHEDULE AND REPORT

A. Initially Acceptable Schedule: Within 5 calendar days after the date of Notice to Proceed (NTP), CONTRACTOR shall submit to COTR/CM for review a progress schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents. COTR/CM will review and make comments about the schedule and will return the progress schedule within 10 days of receipt. CONTRACTOR shall have an additional 10 days to make corrections and adjustments as necessary and to complete and resubmit the schedule. No progress payment shall be made to CONTRACTOR until the schedules are submitted to and acceptable to COTR/CM as provided below. The progress schedule will be acceptable to COTR/CM as being the CONTRACTOR's schedule for the orderly progression of the Work to completion within any specified Milestones and the Contract Times, but such acceptance will neither impose on COTR/CM responsibility for the sequencing, scheduling or progress of the Work nor interfere with or relieve CONTRACTOR from CONTRACTOR's full responsibility thereof.

B. Progress Schedules: Submit adjusted schedule or confirm validity of current schedule with each monthly Application for Payment in accordance with other contract clauses, and at such other times as necessary to reflect: (i) progress of Work to within 5 working days prior to submission; (ii) changes in Work scope and activities modified since submission; (iii) delays in Submittals or resubmittals, deliveries, or Work; (iv) adjusted or modified sequences of Work; (v) other identifiable changes; and (vi) revised projections of progress and completion.

C. Narrative Progress Report: Submit with each monthly submission of progress schedule.

D. Precedent to final payment, provide three copies of any Critical Path Method (CPM) type schedule and diskette utilized with certification that said schedule represents correctly the way the Work was performed.

E. If CONTRACTOR fails to complete activity by its latest scheduled completion date and this failure may extend Contract Times (or Milestones), CONTRACTOR shall, within 7 days of such failure, submit a written statement to the COTR/CM as to how CONTRACTOR intends to correct nonperformance and return to the acceptable current progress schedule. Actions by CONTRACTOR to complete Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.

F. General Requirements:

1. Schedule(s) shall reflect Work logic sequences, restraints, delivery windows, review times, Contract Times, and Milestones set forth in the Agreement and Section 01040, COORDINATION, and shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. The schedule requirement herein is the minimum required. CONTRACTOR may prepare a more sophisticated schedule if such will aid CONTRACTOR in execution and timely completion of Work.
3. Base schedule on standard 5-day Work week.
4. Use Primavera SureTrak latest version or a compatible and approved software.
5. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.
6. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of Contracting Officer and CONTRACTOR.
7. Pursuant to above float-sharing requirement, no time extensions will be granted until a delay occurs which (i) impacts Project's critical path, (ii) consumes available float or contingency time, and (iii) extends Work beyond contract completion date.
8. If CONTRACTOR provides an accepted schedule with an early completion date, Contracting Officer reserves the right to reduce Contract Times to match the early completion date by issuing a deductive Change Order at no change in Contract Price.

G. Format:

1. Monthly Progress Schedule shall be comprehensive computer generated Network Analysis Diagram schedule using CPM, generally as outlined in Associated General Contractors of America (AGC) publication "The Use of CPM in Construction-A Manual for General Contractors and the Construction Industry," latest edition, prepared on reproducible paper, not larger than 30 inches by 42 inches.
   a. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work, identifying Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
   b. Include at a Minimum: Subcontract Work; major and other equipment and critical product design, fabrication, testing, delivery and installation times including required lead time for GOVERNMENT-furnished products, FSSC installation of Simulator and associated equipment, move-in and other preliminary activities, Project closeout and cleanup, completion dates, submittals that may impact critical path, and system/subsystem/component testing, facility startup, and training activities that may impact critical path.
   c. Develop subschedules to further define critical portions of the Work as needed.
   d. Indicate dates for early- and late-start, early- and late-finish, float and duration.
   e. No activity duration, exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 day nor more than 15 working days, unless otherwise approved by the COTR/CM.
   f. Activity duration for Submittals review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from the Contracting Officer.
   g. Bi-weekly Schedule Submissions: Include overall percent complete, projected and actual; and percent completion progress for each listed activity.
   h. Prepare schedule, AF Form 3065, report listing information for each activity in network diagram in tabular format, and sorted according to:
      1) Early-start, within responsibility.
      2) Early-start.
      3) Activity number sequence.
      4) Activity number sequence with predecessor and successor activity.

H. Narrative Progress Report:

1. Include, as a minimum:
   a. Summary of Work completed during the past period between Narrative Progress Reports.
   b. Work planned during the next period.
   c. Explanation of differences between summary of Work completed and Work planned in previously submitted Narrative Progress Report.
   d. Current and anticipated delaying factors and their estimated impact on other activities and completion Milestones.
   e. Corrective action taken or proposed.

1.4 CLAIMS FOR ADJUSTMENT OF CONTRACT TIMES

A. Where Contracting Officer has not yet rendered formal decision on CONTRACTOR's claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in progress schedule, CONTRACTOR shall reflect that amount of time adjustment in progress schedule as Contracting Officer may accept as appropriate for the interim. It is understood and agreed that such interim acceptance by Contracting Officer will not be binding and will be made only for purpose of continuing to schedule Work, until such time as formal decision as to an adjustment, if any, of the Contract Times acceptable to the Contracting Officer has been rendered. CONTRACTOR shall revise progress schedule prepared thereafter in accordance with Contracting Officer's formal decision.

1.5 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are part of this Specification.

1. AF Form 3064—Contract Progress Schedule.
2. AF Form 3065—Contract Progress Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01420
ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES (SCOPE)

A. The work covered by this section consists of furnishing all labor, materials, and equipment, and performing all work required for the prevention of environmental degradation during and as a result of construction operations under this contract. These requirements are in addition to any environmental protection requirements in other provisions of these specifications. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents, not naturally occurring at the site, which adversely affect human health or welfare; unfavorable alter ecological balances important to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and recreational purposes. The control of environmental pollution by the contractor requires consideration of air, water, and land and involves noise control, solid waste management and management of radiant energy and radioactive materials, as well as other pollutants. This section also requires the protection of cultural and historic resources.

B. CONTRACTOR shall coordinate the work of this section with the work called for under the various sections of the Contract.

C. Contact the 126 CES/CEV at 618-222-4876, through the COTR, concerning the content of these requirements.

1.2 CONTRACTOR'S GENERAL ENVIRONMENTAL COMPLIANCE OBLIGATIONS

A. CONTRACTOR and any subcontractor, agent or representative shall comply with all applicable Federal, State, and local laws and regulations providing for environmental protection and pollution control and abatement including but not limited to the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Toxic Substances Control Act, Federal Insecticide Fungicide and Rodenticide Act, Coastal Zone Management Act, Endangered Species Act, National Historic Preservation Act, Safe Drinking Water Act, Emergency Planning and Community Right-to-Know Act Oil Pollution Act and Pollution Prevention Act. CONTRACTOR has the duty to determine for itself where such laws and regulations apply. Although the CONTRACTOR may request assistance from the Contracting Officer in delineating applicable

environmental laws and regulations. CONTRACTOR has an independent responsibility to make its own determination and to do so in a timely fashion.

B. Hazardous material spills: Spills shall be immediately contained, if possible, and reported to the COTR. The COTR will advise CEV.

C. The CONTRACTOR shall not discharge anything into the sanitary sewer system without coordination and approval from COTR who will coordinate with CEV.

D. The CEV may conduct inspections without notice at on-base work sites to ensure environmental compliance. Any items of non-compliance will be reported to the COTR.

1.3 FINES OR PENALTIES FOR ENVIRONMENTAL NON-COMPLIANCE

A. The CONTRACTOR shall be responsible for paying any fines or penalties assessed against the Air Force for environmental violations resulting from acts or omissions of the contractor or its employees, subcontractors, or agents. This obligation is in addition to any fines or penalties which may be assessed against the contractor for the same conduct. CONTRACTOR may either reimburse these fines or penalties through the Contracting Officer, or with the consent of CEV, conveyed through the Contracting Officer, the CONTRACTOR may pay such fines or penalties directly to the regulatory agency or agencies concerned.

1.4 CONTRACTOR'S LIABILITY FOR ENVIRONMENTAL DAMAGES

A. CONTRACTOR agrees to hold harmless and indemnify the Air Force for any and all damages of any kind resulting from environmental violations by the CONTRACTOR, CONTRACTOR's employees or agents or subcontractors. Damages includes but is not limited to personal injury, property damage (including diminution of value), or death, environmental restoration and response costs, natural resource damages, expert witness and attorney's fees, and reimbursement of any and all expenses incurred to obtain permits as a result of CONTRACTOR's failure to identify or obtain permits.

1.5 CONTACTS WITH ENVIRONMENTAL REGULATORY OFFICIALS

A. CONTRACTOR shall, through the Contracting Officer, immediately advise the installation environmental management function of the content of all contact with federal, state or local environmental regulators, before, during and after the performance of this contract concerning the performance of this contract.

PART 2 PERMITS

2.1 PERMITS NEEDED FOR CONSTRUCTION, EXCAVATION, MODIFICATION, RENOVATION, DEMOLITION, INSTALLATION, OR OTHER ALTERATION OF BUILDING, STRUCTURES, EQUIPMENT, INSTALLATIONS, REAL PROPERTY, OR SYSTEMS ON A GOVERNMENT INSTALLATION

A. CONTRACTOR shall, after consultation with the CEV, identify all Federal, State or local permit requirements under all applicable environmental laws and regulations as defined in paragraph 1.2.A above. CONTRACTOR shall then prepare and submit in draft all applicable permit applications and all supporting data to the Contracting Officer, who will submit same to the CEV. Permits that must be submitted by the CEV will be submitted by them. Applications for permits that must be submitted by the CONTRACTOR will be returned to the CONTRACTOR after review.

2.2 COMPLIANCE WITH EXISTING INSTALLATION-HELD PERMITS

A. The USAF holds permits at Scott AFB. The CONTRACTOR shall provide the Contracting Officer with notice of any activities it plans to undertake which may require the CEV to perform any action regarding these permits, such as requesting a permit modification or reporting of required information. CONTRACTOR will provide such notice as far in advance of planned activity as is practicable.

PART 3 MATERIALS

3.1 RECYCLED MATERIALS

A. Materials used in this contract shall be, to the greatest extent practicable and consistent with financial prudence, made of recycled materials or with materials that are recyclable. Submit Affirmative Procurement Plan, compliance with FAR 52.223-9 submit estimates of the percentage of recovered materials and FAR 52.223-4. Recovered material certification as found at www.epa.gov/cpg/products.htm.

3.2 ASBESTOS

A. Asbestos material will not be included in this project.

3.3 POLYCHLORINATED BIPHENYL'S (PCBS)

A. PCBs will not be used or included in this project.

3.4 LEAD-BASED PAINT

A. Lead-based paint will not be included in this project.

3.5 OZONE-DEPLETING SUBSTANCES

A. "Class I substance," as used in this clause, means any substance designated as Class I by the Environmental Protection Agency (EPA)(40 CFR Part 82), including but not limited to chlorofluorocarbons, halons, carbon tetrachloride and methyl chloroform.

B. "Class II substance," as used in this clause, means any substance designated as Class II by EPA (40 CFR Part 82), including but not limited to hydrochlorofluorocarbons.

C. As required by 42 USC 7671j(b), (g) and (d) and 40 CFR Part 82, Subpart E, the CONTRACTOR shall label products which contain Class I or Class II ozone-depleting substances or are manufactured with a process that uses Class I or Class II ozone-depleting substances, or containers of Class I or Class II ozone-depleting substances, as follows:

WARNING: Contains (or manufactured with, if applicable) _____ * _____ (a) substance(s) which harm(s) public health and the environment by destroying ozone in the upper atmosphere." *The CONTRACTOR shall insert the name of the substance(s).

CONTRACTOR shall ensure no Class I ozone-depleting substances are used on Scott AFB without prior approval of CEV.

The CONTRACTOR shall comply with the applicable requirement of Sections 608 and 609 of the Clean Air Act (42 IS 7671g, National Recycling and Emission Reduction Program and 7671h, Servicing of Motor Vehicle Air Conditioners) as each or both apply to the contract.

3.6 PESTICIDES

A. Except as may be specified elsewhere in this contract, CONTRACTOR will not apply any pesticides (such as herbicides or weed-killers, insecticides, or rodenticides) without the specific written prior approval of the 375th CEV.

PART 4 EXECUTION (WORK PRACTICES)

4.1 GENERAL: SITE DISTURBANCE DURING CONSTRUCTION ACTIVITIES

A. CONTRACTOR shall use industry-recognized best management practices to avoid creation of fugitive dust emissions and to avoid and control storm water runoff from the construction site and any temporary roads that may be used for access to it. Water sprinkling may be used to control dust. CONTRACTOR shall perform all work under this contract in such a manner that no pollutants of any kind are released into ditches, storm drains, streams, lakes or other surface waters of the site.

4.2 PROTECTION OF WATER RESOURCES

A. General: The CONTRACTOR shall not pollute storm drainage, streams, lakes or reservoirs with fuels, oils, bitumens, calcium chloride, acids, construction wastes or other harmful materials. It is the responsibility of the CONTRACTOR to investigate and comply with all applicable federal, state and municipal regulations.

B. Spillage: The CONTRACTOR shall take special measure to prevent chemical, fuels, oils, greases, bituminous materials, waste washings, herbicides, cement and surface drainage from entering public waters. In the event of a spill the Base Fire Department and Environmental Office shall be notified immediately through the COTR.

C. Wading and Curing Water: Water used in aggregate processing, concrete curing, foundation and concrete lift clean-up and other waste water shall not be allowed to enter the storm drainage system.

4.3 PROTECTION OF LAND RESOURCES

A. General: It is intended that the land resources within the project boundaries and outside the limits of permanent work performed under this contract be preserved in their present condition or be restored to a condition after completion of construction that will appear to the natural and not detract from the appearance of the project. The CONTRACTOR shall limit his construction activities to areas defined by the Drawings or Specifications.

B. Prevention of Landscape Defacement: Except in area marked on the plans to be cleared, the CONTRACTOR shall not deface, remove, cut, injure or destroy trees or shrubs without special authority. No ropes, cables or guys shall be fastened or attached to any existing trees for anchorage unless specifically authorized by the Contracting Officer. The CONTRACTOR shall in any event be responsible for any damage resulting from such use.

C. Restoration of Landscape Damage: Any trees or other landscape features scarred or damaged by the CONTRACTOR s equipment or operations shall be restored as nearly as possible to the original condition at the CONTRACTOR's expense. The Contracting Officer will decide what method of restoration shall be used, and whether damaged trees shall be treated and heeled or removed and disposed of. All scars made on trees not designated on the plans to be removed by equipment construction operations or by the removal of limbs larger than 1-inch in diameter shall be coated immediately with an approved tree wound dressing, all trimming or pruning shall be performed in an approved manner by experienced landscape personnel. Tree trimming with axes shall not be permitted. Trees that are to remaining either within or outside established clearing limits that are subsequently damaged by the CONTRACTOR and are beyond saving in the opinion of the Contracting

Officer shall be immediately removed and replaced with a nursery-grown tree of the same species.

PART 5 WASTE DISPOSAL

5.1 POLLUTION PREVENTION

A. The CONTRACTOR should use prior planning to find those materials that will minimize the creation of waste in general and hazardous waste in particular.

5.2 WASTE DISPOSAL FOR CONTRACTS TO BE PERFORMED ON GOVERNMENT FACILITIES

A. Hazardous Waste Generation, Handling and Disposal: Work under this contract is to be performed on a government facility. According to rules and procedures of the United States Environmental Protection Agency, the federal facility is required to have a generator identification number under the Resource Conservation and Recovery Act (RCRA) and to be responsible for hazardous wastes (as defined under RCRA) produced, managed, stored, disposed on or transported from the facility. Accordingly, contractor will, to the greatest extent practicable, use materials, processes and techniques that will avoid the creation of hazardous waste. Prior to generation of hazardous materials and hazardous waste on a federal facility under this contract, contractor shall coordinate all planned activities regarding hazardous materials and hazardous waste with CEV office through the COTR. CONTRACTOR shall submit a written waste management and disposal plan to CEV, through the Contracting Officer/COTR, for their approval. CONTRACTOR shall follow this plan once is has been approved by the Contracting Officer/COTR. Under no circumstances will contractor bring hazardous waste onto the facility.

B. Disposal of Non-RCRA Wastes: All non-hazardous wastes generated on the facility as a result of this contract must be disposed of properly. Prior to creation of such wastes, the CONTRACTOR shall submit to CEV function, through the COTR, a plan for disposal of wastes. Such plan shall include the types of waste to be created, how they shall be stored, managed and disposed. CONTRACTOR shall follow this plan once it has been approved by the Contracting Officer/COTR. Such wastes will not be created until approved by the Contracting Officer/COTR.

C. Consolidated Waste Disposal Plans: CONTRACTOR may, at CONTRACTOR's option, submit for approval as specified above one consolidated plan for handling hazardous and non hazardous wastes.

PART 6 UNEXPECTED SITE CONDITIONS

6.1 CONTAMINATED SOIL OR GROUNDWATER

A. Unless otherwise specified elsewhere in this contract, site has been inspected and is, consistent with best professional judgment, free of environmental contamination or pollution. However, unexpected conditions can always arise. CONTRACTOR or subcontractor personnel may encounter soil or groundwater that is suspected to be contaminated either because of odors, colors, free liquids or other suspicious conditions. Should this occur, CONTRACTOR will immediately notify the CEV, through the COTR, and take necessary initial measures to protect workers, the site and other personnel.

6.2 UNEXPLODED MUNITIONS

A. No munitions or munitions-related materials are known or expected to be present on site. However, should suspected munition-type material be encountered CONTRACTOR should immediately notify Explosive Ordinance Disposal (EOD) at (618) 256-5960, or 375th CEV at (618) 256-2092, and receive advice before disturbing the questionable material.

END OF SECTION

SECTION 01430
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 DEFINITIONS

A. Maintenance Operation: As used in the Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

B. System and Subsystem: Refer to Section 01650, STARTING OF SYSTEMS/ COMMISSIONING.

1.2 QUALITY ASSURANCE

A. Manuals for equipment and systems shall be prepared by equipment manufacturer or system Supplier.

1.3 SEQUENCING AND SCHEDULING

A. Manual Outline: Submit detailed outline of each manual prior to preparation of Preliminary Manuals.

B. Manuals for Equipment and Systems:

1. Preliminary Manuals: Submit prior to shipment date for equipment, system, subsystem, or component. Include copy of warranties, Bonds, and service agreements if specified.
2. Final Manuals: Submit not less than 30 days prior to equipment or system field testing or startup.

C. Manuals for Materials and Finishes:

1. Preliminary Manuals: Submit at least 30 days prior to request for final inspection.
2. Final Manuals: Submit within 10 days after final inspection.

1.4 GENERAL

A. Furnish for each item of equipment or system as specified in the individual Specification sections.

B. Prepare data for use by 126th ARW personnel in the form of an instructional manual and on electronic media.

C. Manual Format:

1. Size: 8-1/2 inches by 11 inches.
2. Paper: 20-pound minimum, white for typed pages.
3. Text: Manufacturer's printed data, or neatly typewritten.
4. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
5. Provide fly-leaf for each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.
6. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
7. Cover: Identify each volume with typed or printed title "FACILITY NO. ____, OPERATION AND MAINTENANCE MANUAL, VOLUME NO. ____ OF ____," if applicable, and list:
   a. Project title.
   b. Designate the system or equipment for which it is intended.
   c. Identity of separate structure as applicable.
   d. Identity of general subject matter covered in manual. Identity of equipment number and Specification section.
8. Assemble and bind material in CSI format, as much as possible.
9. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.
10. Binders:
    a. Preliminary Manuals: Heavy paper covers.
    b. Final Manuals: Commercial quality, substantial, permanent, three-ring, D-ring binders with durable, cleanable, white-colored, plastic covers.
11. Table of contents neatly typewritten, arranged in CSI format:
    a. CONTRACTOR, name of responsible principal, address, and telephone number.
    b. List of each product required to be included, indexed to content of each volume.
    c. List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
       1) Identify area of responsibility of each.
       2) Provide local source of supply for parts and replacement.

d. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.

12. Product Data:
    a. Include only those sheets that are pertinent to specific product.
    b. Clearly annotate each sheet to:
        1) Identify specific product or part installed.
        2) Identify data applicable to installation.
        3) Delete references to inapplicable information.
13. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
    a. Relations of component parts of equipment and systems.
    b. Control and flow diagrams.
    c. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
    d. Do not use Project record documents as maintenance manual drawings.
    e. Provide reinforced punched binder tab, bind in with text.
    f. Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
    g. Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
    h. Identify Specification section and product on Drawings and envelopes.
14. Instructions and Procedures: Within text, as required to supplement product data.
    a. Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.
    b. Organize in a consistent format under separate heading for each different procedure.
    c. Provide a logical sequence of instructions for each procedure.
    d. Provide information sheet for 126th ARW personnel, including:
        1) Proper procedures in the event of failure.
        2) Instances that might affect the validity of warranties or Bonds.
15. Warranties, Bonds, and Service Agreements: In accordance with Section 01700, CONTRACT CLOSEOUT.

D. Electronic Format: All electronic files shall be delivered on CD-RW.

1. Text portions of the manual: Microsoft Word, most current version.
2. Drawings: .pdf files (Adobe Acrobat).

1.5 SUBMITTAL PROCEDURE

A. Preliminary Manuals:

1. Submit three copies for CM's review.
2. Disposition: In accordance with Section 01300, SUBMITTALS.
3. If Accepted:
   a. One copy will be returned to CONTRACTOR.
   b. One copy will be forwarded to the COTR.
   c. One copy will be retained in CM's file.
   d. Submit two paper copies of Final Manual and two copies of all materials on two CD-RWs.
4. If Rejected:
   a. Two copies will be returned to CONTRACTOR with CM's comments for revision.
   b. One copy will be retained in CM's file.
   c. Resubmit three copies revised Preliminary copies for CM's review.

B. Final Manuals:

1. If different than accepted Preliminary Manuals, submit:
   a. Two copies of any necessary supplemental material, including revised table of contents.
   b. Instructions for insertion of supplemental material in unreturned sets.
2. If Final Manuals are acceptable, CONTRACTOR will be so notified.
3. If rejected, and at CM's option:
   a. All copies will be returned to CONTRACTOR for revision, or;
   b. All copies will be retained by CM and the necessary revision data will be requested from CONTRACTOR.

1.6 MANUALS FOR EQUIPMENT AND SYSTEMS

A. Content for Each Unit (or Common Units) and System:

1. Description of unit and component parts, including controls, accessories, and appurtenances:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.

2. Operating Procedures:
   a. Startup, break-in, routine, and normal operating instructions.
   b. Test procedures and results of factory tests where required.
   c. Regulation, control, stopping, and emergency instructions.
   d. Description of operation sequence by control manufacturer.
   e. Shutdown instructions for both short and extended durations.
   f. Summer and winter operating instructions, as applicable.
   g. Safety precautions.
   h. Special operating instructions.
   i. Installation instructions.
3. Maintenance and Overhaul Procedures:
   a. Routine operations.
   b. Guide to troubleshooting.
   c. Disassembly, removal, repair, reinstallation, and reassembly.
4. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
5. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
6. Spare parts ordering instructions.
7. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
8. Manufacturer's printed operating and maintenance instructions.
9. As-installed, color-coded piping diagrams.
10. Charts of valve tag numbers, with the location and function of each valve and valve position (normally open or normally closed).

B. Maintenance Summary:

1. Compile an individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or subunits.
2. Format:
   a. Use Maintenance Summary Form bound with this section, or an electronic facsimile of such.
   b. Each Maintenance Summary may take as many pages as required.
   c. Use only 8-1/2-inch by 11-inch size paper.
   d. Complete using typewriter or electronic printing.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.

4. Recommended Spare Parts:
   a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
   b. “Unit” is the unit of measure for ordering the part.
   c. “Quantity” is the number of units recommended.
   d. “Unit Cost” is the current purchase price.

C. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including all control and lighting systems.
2. Circuit Directories of Panelboards:
   a. Electrical service.
   b. Controls.
   c. Communications.
3. List of electrical relay settings, and control and alarm contact settings.
4. Electrical interconnection wiring diagram, including control and lighting systems.
5. As-installed control diagrams by control manufacturer.
6. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Sequences required.
   c. Safety precautions.
   d. Special operating instructions.
7. Maintenance Procedures:
   a. Routine operations.
   b. Guide to troubleshooting.
   c. Adjustment and checking.
   d. List of relay settings, control and alarm contact settings.
8. Manufacturer's printed operating and maintenance instructions.
9. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

1.7 MANUALS FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
   a. Catalog number, size, and composition.
   b. Color and texture designations.
   c. Information required for reordering special-manufactured products.
2. Instructions for Care and Maintenance:
   a. Manufacturer's recommendation for types of cleaning agents and methods.
   b. Cautions against cleaning agents and methods that are detrimental to product.
   c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
   a. Applicable standards.
   b. Chemical composition.
   c. Details of installation.
2. Instructions for inspections, maintenance, and repair.

1.8 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION”, are part of this Specification.

1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

FACILITY NO.: _____ LOCATION NO.: _____

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. PART NO. / SERIAL NO.: _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

6. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE _____

   a. Name_____ Telephone No. _____

   b. Address _____

8. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

9. LUBRICANT LIST

Reference Symbol	Shell	Standard Oil	Gulf	Arco	Or Equal
List symbols used in No. 7. above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

10. RECOMMENDED SPARE PARTS FOR GOVERNMENT'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01500
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of Nurserymen: American Standards for Nursery Stock.
2. U.S. Weather Bureau, "Rainfall-Frequency Atlas of the U.S. for Durations From 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years."
3. U.S. Department of Agriculture, "Urban Hydrology for Small Watersheds."
4. Federal Emergency Management Agency.
5. NFPA, National Fire Prevention Standard for Safeguarding Building Construction Operations.

1.2 SUBMITTALS

A. Administrative Submittals: Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.

B. Shop Drawings:

1. Temporary Utility Submittals:
   a. Electric power supply and distribution plans.
   b. Water supply and distribution plans.
   c. Drainage plans.
2. Temporary Construction Submittals:
   a. Access Roads: Routes, cross-sections, and drainage facilities.
   b. Parking area plans.
   c. CONTRACTOR's field office, storage yard, and storage building plans, including gravel surfaced area.
   d. Fencing and protective barrier locations and details.
   e. Staging area location plan.
   f. Traffic Control and Routing Plans: As specified herein, and proposed revisions thereto.
   g. Plan for maintenance of existing base operations.

3. Temporary Control Submittals:
   a. Noise control plan.
   b. Dirt/dust control plan: Submit truck and material handling routes and a plan for controlling dirt, debris, and dust from accumulating on base roadways the CONTRACTOR uses for any purpose. The plan, as a minimum, shall identify the subcontractor and equipment to be used for cleaning along the haul route roadways and measures to be used to reduce dirt, dust, and debris from roadways, as specified herein.

1.3 MOBILIZATION

A. Mobilization shall include, but not be limited to, these principal items:

1. Obtaining required permits.
2. Moving CONTRACTOR's field office and equipment onto site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite communication facilities, including telephones.
5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
6. Arranging for and erection of CONTRACTOR's work and storage yard.
7. Posting OSHA required notices and establishing safety programs and procedures.
8. Having the CONTRACTOR's superintendent at the site full time.

B. Use area designated as CONTRACTOR STAGING AREA for CONTRACTOR's temporary facilities as shown on Drawings.

1.4 CONTRACTOR'S USE OF PREMISES

A. Lands furnished by the GOVERNMENT upon which CONTRACTOR shall perform the Work are as shown in Plans.

1.5 PERMITS

A. Permits, Licenses, or Approvals: Obtain in accordance with appropriate sections of the Contract Documents.

1.6 PROTECTION OF WORK AND PROPERTY

A. Comply with Scott AFB's safety rules while on Scott AFB property.

B. Keep Contracting Officer/COTR informed of all accidents on the site and related claims.

C. Use of Explosives: No blasting or use of explosives will be allowed on the site.

D. During the performance of the Work, CONTRACTOR is responsible for adapting its means, methods, techniques, sequences and procedures of construction to allow Scott AFB to maintain operation as described in Section 01010, SUMMARY OF WORK, at the existing level of facility production and consistent with applicable permit requirements, and Laws and Regulations. In performing such Work and in cooperating with Scott AFB to maintain operations, it may be necessary for the CONTRACTOR to plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items which will be included within the Contract Price.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

A. Lighting: Provide temporary lighting at least to meet all applicable safety requirements to allow erection, application or installation of materials and equipment, and observation or inspection of the Work.

B. Heating, Cooling, and Ventilating:

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for the installation of materials, and to protect materials, equipment, and finishes from damage due to temperature or humidity.
2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Pay all costs of installation, maintenance, operation, removal, and fuel consumed.
4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.

3.2 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within rights-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. No residence or business shall be cut off from vehicular traffic unless special arrangements have been made through the COTR.
3. Maintain in continuous service all existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along the line of work, unless other arrangements satisfactory to owners of said utilities have been made.
4. Where completion of Work requires temporary or permanent removal and/or relocation of an existing utility, coordinate all activities with owner of said utility and perform all work to their satisfaction.
5. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
6. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
7. In areas where the CONTRACTOR's operations are adjacent to or near a utility such as gas, telephone, television, electric power, water, sewer, or irrigation system and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection thereof have been made by the CONTRACTOR.
8. Do not impair operation of the existing sewer systems. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures. Maintain original site drainage wherever possible.

B. Trees, Plantings, and Vegetation:

1. Protect from damage and preserve trees, shrubs, and other plants outside the limits of the Work and within the limits of the Work which are designated on the Drawings to remain undisturbed.
   a. Where practical, tunnel beneath trees when on or near the line of trench.
   b. Employ hand excavation as necessary to prevent tree injury.
   c. Do not stockpile materials or permit traffic within drip lines of trees.
   d. Provide and maintain temporary barricades around trees.
   e. Water vegetation as necessary to maintain health.

f. Cover temporarily exposed roots with wet burlap, and keep the burlap moist until soil is replaced around the roots.
g. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of the COTR/CM.
h. Dispose of removed trees in a legal manner off Scott AFB.

2. The balling and burlapping of trees indicated for replacement shall conform to the recommended specifications set forth in the American Standards for Nursery Stock, published by American Association of Nurserymen. All balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by the ball and not by the top.
3. In the event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.
4. Replace each plant that dies as a result of construction activities.
5. Any grass (or annual grass) within the construction and storage sites shall be cut to a 4-inch height at least once a week during the growing season, unless the grass area is not visible to the public. The grass around the fences shall be trimmed at time of grass cutting to keep a neat appearance. If a construction or safety fence is not used for a specific reason, approved by the base civil engineering representative, then any grass or annual weeds within the construction area shall be maintained in a similar fashion as previously described. Grass or weeds growing on stockpiled earth shall be maintained as described above.

C. Existing Structures: Where CONTRACTOR contemplates removal of small structures such as signposts, and culverts that interfere with CONTRACTOR's operations, obtain approval of property owner and COTR/CM. Replace those removed in a condition equal to or better than original.

D. Finished Construction: Protect finished surfaces including concrete floors exposed as well as those covered with composition tile or other applied surfacing.

E. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

F. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain the foundations and parts of the Work free from water.

G. Archaeological Finds:

1. General: Should finds of an archaeological or paleontological nature be made within the limits of the site, immediately notify 126CE and COTR/CM and proceed in accordance with the most stringent requirements of the General Conditions or the Division of Lands permit as issued by the Illinois EPA. A copy of the permit can be obtained from the Contracting Officer. Continue Work in other areas without interruption.
2. Archaeological Finds: Evidence of human occupation or use of an area within the contract limits. Evidence may consist of skeletons, stone, or other utensils, or evidence of habitations or structures.
3. Paleontological Finds: Evidence of prehistoric plant or animal life, such as skeletons, bones, fossils, or casts and other indications such as pictographs.
4. Contracting Officer may order Work stopped in other areas if, in Contracting Officer's opinion, the find is more extensive than may appear from uncovered material.
5. Protection of Finds:
   a. Cover, fence, or otherwise protect finds until notice to resume Work is given.
   b. Cover finds with plastic film held in place by earth, rocks, or other weights placed outside the find. Should additional backfilling be necessary for safety or to prevent caving, place backfill material loosely over the plastic film.
   c. Sheet or shore as necessary to protect excavations underway. Place temporary fence to prevent unauthorized access.
   d. Dewater finds made below the water table as necessary to protect construction Work underway. Divert groundwater or surface runoff away from find by ditching or other acceptable means.

H. Endangered Species: None are know at this time. Take the following actions:

1. Take precautions necessary and prudent to protect native endangered flora and fauna.
2. Notify COTR/CM of construction activities that might threaten endangered species or their habitats.

3. COTR/CM will mark areas known as habitats of endangered species prior to commencement of onsite activities.
4. Additional areas will be marked by COTR/CM, as other habitats of endangered species become known during construction.

3.3 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to the site.

B. Noise Control:

1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
2. Noise Control Plans: Proposed plan to mitigate construction noise impacts and to comply with noise control ordinances including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:

1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to an existing waterway.
2. Prior to commencing excavation and construction, submit plan for review to Contracting Officer showing procedures intended to handle and dispose of sewage, groundwater, and stormwater flow, including dewatering pump discharges.
3. Comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, “Guidelines for Erosion and Sedimentation Control Planning” and “Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity,” and “Erosion and Sediment Control-Surface Mining in Eastern United States.”
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect Work and existing facilities from flooding during construction period.

3.4 TEMPORARY OFFICES, STORAGE YARDS AND BUILDINGS

A. Notify COTR/CM at least 5 days prior to mobilizing onto work site.

B. Coordinate requirements with Section 01600, MATERIAL AND EQUIPMENT.

C. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions. The storage yard at the construction site will be limited to the materials needed to be used within a week. Enclose storage areas with approved, new 5’ chain link.

D. Temporary Office and Storage Facilities:

1. CONTRACTOR shall provide and maintain facilities, including cleaning and refuse removal, make provisions for recycling materials consistent with Scott AFB policies, and repair any damage to the facility to restore the facility to the condition at occupancy.

3.5 ACCESS ROADS

A. Construct access roads as shown and within easements, rights-of-way, or Project limits. Utilize existing roads where shown. Alignments for new routes must be approved by COTR/CM.

B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

C. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.

D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

E. Where access roads cross existing fences, install and maintain gates with like components.

F. Upon completion of construction, restore ground surface disturbed by access road construction to original grade. Replace damaged or broken culverts with new culvert pipe of same diameter and material.

3.6 CLEANING DURING CONSTRUCTION

A. In accordance with the General Conditions, as may be specified in Specification sections, and as required herein.

B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose.

C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish.

1. Dumpsters shall be equipped with a secure cover, painted brown, and be free of graffiti. The cover shall be closed at all times, except when being loaded with trash and debris. Dumpsters will be located behind the construction fence or out of the public view. Site dumpsters shall be emptied offsite at least once a week, or as needed to keep the site free of debris and trash. Dumpsters that do not have lids shall not have debris piled higher than the sides of the dumpsters before emptying.
2. A minimum of one trash container shall be provided for every 93 square meters (1,000 square feet) of construction site area. The containers shall be 208 liters (55 gallons) in capacity, painted brown, and free of graffiti. The trash container will be located behind the construction fence or out of the public view. Trash containers shall be emptied at least once a day.

D. At least daily, brush sweep the entry drive and roadways, and all other streets and walkways directly adjacent to the construction site. Sweeping of the streets not adjacent to the construction site will be performed by others.

END OF SECTION

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by CONTRACTOR or GOVERNMENT for the Project, or taken from previously purchased stock and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change the meaning of such other terms used in the Contract Documents as those terms are self-explanatory and have well recognized meanings in the construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in the manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.2 SUBMITTALS

A. Administrative Submittals:

1. List of all proposed substitute or "or-equal" items/methods.
2. Schedule of factory tests required by Contract Documents. Identify tests for which COTR/CM's presence has been specified.

B. Quality Control Submittals:

1. Factory Tests: As specified in the individual Specifications.
   a. Procedures: Preliminary outlines.
      1) Final Accepted Procedures: Prior to start of factory testing.
   b. Test Documentation: Results of successful testing, including certification of procedures and results.

1.3 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Spare Parts, Special Tools, Test Equipment, Expendables, and Maintenance Materials:

1. Furnish as required by the Specifications prior to operation of the equipment by 126th ARW Personnel, or 75 percent Project completion, whichever occurs first.
2. Properly package to avoid damage, in original cartons insofar as possible. Replace parts damaged or otherwise inoperable.
3. Firmly fix to, and prominently display on, each package.
   a. Minimum 3-inch by 6-inch manila shipping tag with the following information printed clearly:
      1) Manufacturer's part description and number.
      2) Applicable equipment description.
      3) Quantity of parts in package.
      4) Equipment manufacturer.
      5) Applicable Specification section.
      6) Name of CONTRACTOR.
      7) Project name.
4. Notify COTR/CM upon arrival.

D. Protect equipment from exposure to the elements and keep thoroughly dry and dustfree at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.

E. Request a minimum 7-day advance notice of shipment from manufacturers. Upon receipt of manufacturer's advance notice of shipment, promptly notify COTR/CM of anticipated date and place of arrival.

F. Factory Test Results: Reviewed and accepted by COTR/CM before product shipment as required in individual Specification sections.

1.4 DELIVERY AND INSPECTION

A. Deliver products in accordance with the accepted current progress schedule and coordinate to avoid conflict with Work and conditions at the site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label date of manufacture and shelf life, where applicable. Include UL labels on products so specified.

C. Unload products in accordance with manufacturer's instructions for unloading, or as specified. Record the receipt of products at the site. Inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from the site and expedite delivery of identical new undamaged products and remedy incomplete or lost products to provide that specified, so as not to delay the progress of the Work.

1.5 HANDLING, STORAGE, AND PROTECTION

A. Handle products in accordance with the manufacturer's written instructions, and in a manner to prevent damage. Store products, upon delivery, in accordance with manufacturer's instructions, with labels intact and legible, in approved storage yards or sheds. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Contracting Officer.

B. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered but not installed in the Work.

C. Store electrical, instrumentation, and control products, and equipment with bearings in weathertight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulation against moisture, water, and dust damage. Connect and operate continuously all space heaters furnished in electrical equipment.

D. Store fabricated products aboveground, on blocking or skids, and prevent soiling or staining. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

E. Store finished products that are ready for installation in dry and well ventilated areas. Do not subject to extreme changes in temperature or humidity.

F. Hazardous Materials: Prevent contamination of personnel, the storage building, and the site. Meet the requirements of the product specifications, codes, and manufacturer's instructions.

1.6 SUBSTITUTE AND "OR-EQUAL" PRODUCTS

A. Meet the requirements of the General Conditions, the Specification sections, and as set forth herein.

B. Listing of proposed substitute or "or-equal" items or methods.

1. With consideration of the additional evaluation time necessary for COTR/CM's review of such items, indicate for each item the review status (either substitute or "or-equal") and estimated submission date.
2. CONTRACTOR, in indicating the review status of the proposed item, acknowledges that the time shown for COTR/CM's review on the current accepted schedule is sufficient only to allow COTR/CM to accomplish review for the status indicated and not sufficient to perform both a review for "or-equal" status and a subsequent review for substitute status on the same product.
3. COTR/CM may return unreviewed those submissions (i) not shown on the current accepted schedule, (ii) for which the review status differs from that indicated on the accepted list unless previously approved in writing by COTR/CM, (iii) not in accordance with the General Conditions as specified herein, (iv) which are incomplete, or (v) which are uncertified, in which case CONTRACTOR shall provide the specified product.
4. Contractor shall be responsible for demonstrating that proposed substitute or "or equal" items provide equal performance, durability and quality to the specified item, and for all adjustments required to accommodate the proposed item if approved.

C. Submit six copies of proposed substitute or "or-equal" item/method, to include all supporting data to allow COTR/CM's review. Complete, sign, and transmit with each proposed substitute or "or-equal" item/method submission.

D. Disposition of Substitute Item/Method:

1. Accepted: COTR/CM will evidence such acceptance by recommendation of a Change Order for CONTRACTOR and Contracting Officer execution. Such Change Order will accompany COTR/CM's evaluation and acceptance of CONTRACTOR's proposed substitute.

2. Rejected:
   a. One copy retained by CM.
   b. One copy retained by COTR.
   c. One copy retained by Contracting Officer.
   d. One copy returned to CONTRACTOR with a commentary by COTR/CM.
   e. Remaining copies will be destroyed.
   f. CONTRACTOR shall provide item specified in Contract Documents.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, and manufacturer's services and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

I. Provide materials and equipment listed by UL wherever standards have been established by that agency.

J. Equipment Finish: Provide manufacturer's standard finish and color, except where specific color is indicated.

K. Special Tools and Accessories: Furnish to 126th ARW Personnel, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Contracting Officer.

2.2 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible. Oil drains with bronze or stainless steel valves and fill plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.

3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.3 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by COTR/CM, notify COTR/CM not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage which necessitates procurement of new products will be considered delays within CONTRACTOR's control.

3.2 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions and as may be specified. Retain a copy of manufacturers' instruction at site, available for review at all times.

F. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.3 FIELD FINISHING

A. In accordance with individual Specification sections.

3.4 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.5 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Contracting Officer.

END OF SECTION

SECTION 01640
MANUFACTURERS' SERVICES

PART 1 GENERAL

1.1 DEFINITIONS

A. Person-Day: One person for 8 hours within regular CONTRACTOR working hours.

1.2 SUBMITTALS

A. Training Schedule: Submit not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.

B. Lesson Plan: Submit proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.

1.3 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system. Additional qualifications may be specified elsewhere.

B. Representative subject to acceptance by COTR/CM. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services when required by an individual specification section, to meet the requirements of this Section.

B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, the time required to perform the specified services shall be considered incidental.

C. Schedule manufacturer's services to avoid conflict with other onsite testing or other manufacturers’ onsite services.

D. Determine, before scheduling services, that all conditions necessary to allow successful testing have been met.

E. Only those days of service approved by COTR/CM will be credited to fulfill the specified minimum services.

F. When specified in individual specification sections, manufacturer's onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Revisiting the site as required to correct problems and until installation and operation are acceptable to COTR/CM.
4. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
5. Assistance during functional and performance testing, and facility startup and evaluation.
6. Training of GOVERNMENT's personnel in the operation and maintenance of respective product as required.
7. Additional requirements may be specified elsewhere.

3.2 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

A. When specified in individual Specification section, submit prior to shipment of product or material.

B. COTR/CM may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Signed by product manufacturer certifying that product or material specified conforms to or exceeds specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to COTR/CM.

3.3 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by the equipment manufacturer's representative.

B. Such form shall certify that the signing party is a duly authorized representative of the manufacturer, is empowered by the manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to assure that the equipment is complete and operational.

3.4 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to GOVERNMENT's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with GOVERNMENT, and familiar with operation and maintenance manual information specified in Section 01430, OPERATION AND MAINTENANCE DATA.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by GOVERNMENT, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01310, PROGRESS SCHEDULES and Section 01650, STARTING OF SYSTEMS/COMMISSIONING.

C. Lesson Plan: When specified, prepare for each required course, containing the following minimum information:

1. Title and objectives.
2. Recommended types of attendees (e.g., managers, engineers, operators, maintenance).
3. Course description and outline of course content.
4. Format (e.g., lecture, self-study, demonstration, hands-on).
5. Instruction materials and equipment requirements.

6. Resumes of instructors providing the training.

D. Prestartup Training:

1. Coordinate training sessions with GOVERNMENT's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals in accordance with Section 01430, OPERATION AND MAINTENANCE DATA.
2. Complete at least 14 days prior to beginning of facility startup.

E. Post-Startup Training: If required in Specifications, furnish and coordinate training of GOVERNMENT's operating personnel by respective manufacturer's representatives.

3.5 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.

1. Forms: Manufacturer's Certificate of Proper Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

GOVERNMENT _____ EQPT SERIAL NO:_____

EQPT TAG NO:_____ EQPT/SYSTEM:_____

PROJECT NO:_____ SPEC. SECTION:_____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with Manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Comments:_____

_____

_____

_____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date:_____, 20

Manufacturer:_____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

SECTION 01650
STARTING OF SYSTEMS/COMMISSIONING
(GOVERNMENT-PURCHASE CONTRACTS)

PART 1 GENERAL

1.1 DEFINITIONS

A. System: A system means the overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment.

B. Functional Testing: Tests necessary to demonstrate that installed equipment and systems function as specified and operate in the manner intended. Functional testing is a prerequisite to performance testing for equipment and systems specified to have a performance test.

C. Performance Testing: Tests necessary to demonstrate, after successful functional testing, that equipment and systems meet specified performance requirements.

D. Startup Period:

1. Startup of any portion of the entire facility is considered complete when, in the opinion of the COTR/CM, the facility or designated portion has properly operated for 7 continuous days without significant interruption. The startup period is in addition to specified functional and performance testing and training.
2. Successful startup of entire facility shall be accomplished prior to determination of substantial completion as defined in the General Conditions.
3. Significant interruption during startup shall include any of the following events:
   a. Failure of CONTRACTOR to maintain 24-hour onsite startup personnel during startup.
   b. Failure to meet specified quality for more than 2 consecutive hours.
   c. Failure of a system (process, control, building service, etc.) that is not permanently corrected within 4 hours after such failure occurs.
   d. Failure of a mechanical equipment unit (electrical, instrument, etc.) that is not permanently corrected within 6 hours after such failure occurs.

e. Failure of an analytical, HVAC, building service, or hoisting equipment unit that is not permanently corrected within 8 hours after such failure occurs.

4. "Permanently corrected" shall consist of all of the following:
   a. Work repaired and replaced to conform with specified requirements.
   b. Parts and components replaced as recommended by original manufacturer and conforming with reviewed submittals.
   c. Piping and valves properly installed and connected.
   d. Wiring properly terminated and enclosed in raceways.
   e. Accessories, including spare parts and lubricants, furnished as specified.
5. Occurrence of a significant interruption shall require startup then in progress to be stopped and restarted after permanent corrections are made.

E. Operation: The operation period begins when the facility has been substantially completed as defined in the General Conditions successfully started as specified in this section, or accepted by the COTR/CM for continuous operation.

1.2 SUBMITTALS

A. CONTRACTOR shall submit the following information for specific equipment where specified in individual sections and in this section:

1. Copy of manufacturer's certification of proper installation before functional testing is started.
2. Copy of installing contractor's testing plan for each applicable equipment item, system, and subsystem reviewed and accepted by manufacturer.
3. Copy of installing contractor's functional test logs, certification of functional testing, and performance test results for each applicable system and subsystem reviewed and accepted by manufacturer.
4. Operation and maintenance instruction for each equipment item and system to be tested.
5. Qualifications and experience record of proposed representatives of manufacturers who will assist testing of equipment and conduct training sessions.
6. Additional Operation and Maintenance Manual information, if needed after completion of testing, as specified in Section 01300, SUBMITTALS.

1.3 TESTING AND STARTUP RESPONSIBILITIES

A. Installing Contractor's Responsibilities: The installing contractor will:

1. Furnish labor and materials, tools, instruments, and services for checking, testing, and startup specified for each equipment item, except for items to be furnished by GOVERNMENT and GOVERNMENT-furnished equipment CONTRACTOR, as specified. This includes such services as manufacturers' representatives, subcontractors, electricians, instrumentation technicians, and pipefitters.
2. Prepare testing schedule and incorporate testing and startup activities in the progress schedule for the work, in accordance with Section 01300, SUBMITTALS and Section 01310, PROGRESS SCHEDULES.
3. Designate one person (other than field superintendent) to be responsible for coordinating and expediting testing and startup responsibilities, and to be present during all pre-startup meetings and available to GOVERNMENT's personnel during the testing and startup.
4. Obtain and furnish qualified manufacturer's representative to assist testing of each equipment type and system for equipment not furnished by GOVERNMENT.
5. Develop a standard testing log to be used as a record of testing of each equipment item and subsystem. This log shall:
   a. Be subject to approval of COTR/CM,
   b. Include subsystem and equipment name,
   c. Have provisions for recording dates of completion for checking, inspection by manufacturer, verification of instrumentation and controls, and completion of subsystem tests, and
   d. Allow space for describing problems remaining with equipment and for signature of COTR/CM and manufacturer's representative indicating acceptance.
6. Notify COTR/CM and respective equipment manufacturers at least 21 days prior to the date when each equipment system is scheduled to be initially started; also submit testing plan stating schedule and quantity and source of utilities, chemicals, and other materials needed.

B. GOVERNMENT's Responsibilities: The GOVERNMENT will:

1. Furnish for CONTRACTOR's use during startup and testing , except as specified in Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS:

a. Electrical power.
b. Potable water W1.
c. Chemicals including chlorine, provided adequate prior notice is given by CONTRACTOR.
d. Waste disposal for testing and startup operations.

2. Furnish GOVERNMENT's representative to witness all tests.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 TESTING PREPARATION

A. Cleaning and Checking: Installing contractor will, prior to initial startup of equipment:

1. Inspect and clean equipment, devices, and connected piping so they are free of foreign material.
2. Lubricate equipment in accordance with manufacturer's instructions.
3. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.
4. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
5. Check power supply to electric-powered equipment for correct voltage.
6. Obtain manufacturer's certification of proper installation, where specified.

B. Ready-To-Test Determination: Equipment shall be determined ready to test by COTR/CM based on the following:

1. Notification by installing contractor of equipment and system readiness for testing.
2. Submittal of testing plan stating detailed procedures including quantity and source of utilities, chemicals, and other materials needed for each test.
3. Receipt of O & M Manuals incorporating review comments.
4. Receipt of manufacturer's certification of proper installation, where specified.
5. Cleanliness of equipment, devices, and connected work.
6. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
7. Availability and acceptability of manufacturer's representative to assist testing of respective equipment, and satisfactory fulfillment of other specified manufacturers' responsibilities.

C. Pretesting Meeting: Installing contractor will arrange a meeting to review the CONTRACTOR's recommended testing procedures for each equipment item and system, at least 2 days prior to the first test run. Manufacturers' representatives shall attend.

3.2 FUNCTIONAL TESTING

A. Subsystem Tests: Installing contractor shall startup and operate the individual components and subsystems that make up each equipment system, as listed below, and as specified in the respective sections in Division 15. Functional testing of a complete system shall not begin until subsystem testing is completed to the COTR/CM's satisfaction.

1. Mechanical HVAC and Hydronic System:
   a. Air Handling Units.
   b. Chiller.
   c. Pumps.
   d. Electrical and Controls: Verify proper operation, including indicating lights and alarms.

B. Equipment and System Tests: Except as otherwise specified for CONTRACTOR, installing contractor will functionally test each separate piece of equipment, and each system requiring simultaneous operation of interdependent equipment, in accordance with the following procedures:

1. Separate items of equipment demonstrated to function properly during subsystem testing shall require no further functional test, if documentation of subsystem testing is accepted by COTR/CM.
2. Functional testing of each system shall begin after subsystems and equipment units have been satisfactorily tested.
3. Functional testing will begin at a time mutually agreed upon by the COTR/CM, manufacturer's representative(s), and CONTRACTOR.
   a. The COTR/CM will be present during tests.
   b. Notify COTR/CM and manufacturer's representative at least 14 days prior to scheduled date of functional tests.
4. Functional testing will be conducted for a minimum period of 3 consecutive days and until every equipment item in each system has demonstrated 24 continuous hours of satisfactory operation. All operational features and controls will be demonstrated during this period, while systems and equipment operate in automatic modes.
5. Performance tests, where specified for individual equipment, shall not begin until functional testing of the complete systems in which they operate is completed to the satisfaction of the COTR/CM.

6. If, in the opinion of the COTR/CM, each system meets the requirements specified, they will be accepted as conforming for purposes of advancing to the performance testing phase. If, in the opinion of the COTR/CM, the functional test results do not meet the requirements specified, the systems will be considered as nonconforming.
   a. In the case of a nonconforming system, advancement to the performance testing phase shall not commence until the installing contractor has made such adjustments, changes, and additions necessary to correct the system and retests it as specified and, in the opinion of the COTR/CM, the system functions as specified.
   b. In the event that a nonconforming system is the result of malfunction of a CONTRACTOR-furnished equipment item, the CONTRACTOR shall immediately take the appropriate action to correct the malfunction. Project delay resulting from failure of the CONTRACTOR to take such action shall be incurred at the CONTRACTOR's sole expense.

C. Documentation: Installing contractor will document subsystem and system tests in writing, on the forms furnished by the COTR/CM, in a format acceptable to the COTR/CM. CONTRACTOR shall review the logs and furnish approval, prior to subsequent performance testing or startup, on the appropriate test logs.

3.3 PERFORMANCE TESTING

A. Testing Fluid: Performance testing shall use material that the equipment or system is designed to handle during normal service conditions, unless otherwise specified.

B. Equipment and Subsystem Tests: Installing contractor will:

1. Clean and check equipment and devices, as specified under Article TESTING PREPARATION, prior to starting equipment and subsystem performance tests.
2. Performance testing will begin at a time mutually agreed upon by the COTR/CM, manufacturer's representative(s), and CONTRACTOR.
   a. The COTR/CM will be present during tests.
   b. Notify COTR/CM and manufacturer's representative at least 14 days prior to scheduled date of performance testing.
3. Provide supplies and materials, including water and chemicals; allowing sufficient advance notice for suppliers and GOVERNMENT.
4. Operate the necessary equipment units as specified in the respective O & M Manuals for a continuous period of 24 hours.

5. Complete acceptable performance testing of all equipment and subsystems included in a system, and submit test documentation, before starting the system performance test.

C. Documentation:

1. Except as specified for CONTRACTOR-furnished equipment test. Installing Contractor will prepare performance test report for equipment and complete systems tested. Summarize test method, include test logs and pertinent calculations, and obtain manufacturer's signed statement recommending continuous operation. CONTRACTOR shall review reports prepared by installing contractor and indicate acceptance or submit written comments to COTR/CM.

D. CONTRACTOR-Furnished Equipment Test: CONTRACTOR shall:

1. Clean and check equipment and devices, as specified under Article TESTING PREPARATION, prior to starting system performance tests.
2. Performance testing will begin at a time mutually agreed upon by the COTR/CM, GOVERNMENT, manufacturer's representative(s), and CONTRACTOR.
   a. The GOVERNMENT or COTR/CM will be present during tests.
   b. Notify COTR/CM, GOVERNMENT, and system manufacturer(s) at least 14 days prior to planned date of performance testing.
3. Obtain supplies and materials, including water and chemicals; allow sufficient advance notice for suppliers and GOVERNMENT.
4. Operate complete system as specified for a continuous period of 24 hours.
5. Prepare and submit performance test report as specified in Paragraph DOCUMENTATION.

3.4 STARTUP

A. Performance testing of all individual equipment and subsystems shall be completed before the startup period begins, unless otherwise allowed by COTR/CM.

B. Installing contractor will prepare startup activity schedule.

1. Schedule shall follow format specified in Section 01300, SUBMITTALS, and Section 01310, PROGRESS SCHEDULES.

2. Examples of startup activities to be conducted are:
   a. Operate all plumbing systems.
   b. Operate all HVAC systems.
   c. Operate all fire alarm and automatic fire protection systems.
   d. Open, close, lock, and unlock all doors and windows to check master keying.
   e. Check all electrical, communications, and lighting systems.
3. Indicate timing and interdependence of activities in the program, indicating each system, subsystem, and unit to be operated. Allow for rotation of standby units with operating units so that each unit is started and stopped at least twice and receives approximately the same elapsed time of operation.

C. After review and revisions requested by COTR/CM, installing contractor will begin the startup activities. If requested, attend a pre-startup meeting not more than 5 days prior to startup to review the program and resolve questions.

D. During startup operations, Installing Contractor will keep complete records of each activity and performance of each system, subsystem, and equipment unit.

3.5 CONTINUOUS OPERATION

A. GOVERNMENT will accept equipment and systems as ready for continuous operation only after successful testing and startup is completed and documented, test and startup reports submitted, and manufacturers' services completed for training of GOVERNMENT's personnel.

B. After successful performance testing of a particular equipment type or system, GOVERNMENT may elect to start up a portion of the equipment or system for continuous operation in accordance with the General Conditions. Such operation will not interfere with testing of other equipment and systems that may still be underway, and shall not preclude the need to start up and demonstrate the portion operated in combination with the rest of the facility when all testing is completed.

END OF SECTION

SECTION 01700
CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 CONSTRUCTION PROJECT ACCEPTANCE PROCEDURES

A. Prefinal Inspection: No Later Than 30 calendar days prior to the completion date or upon Notice of Completion by CONTRACTOR, the Contracting Officer/COTR/CM and the CONTRACTOR will conduct a detailed and thorough inspection to identify construction deficiencies and remaining contractual items (such as systems operating manuals, spare parts lists, as-built drawings, and training requirements). During the inspection they will document the deficiencies on a "punchlist."

B. Final Inspection: No Later Than contract completion date, the CO/COTR will conduct final inspection to ensure all punch list items are completed for building acceptance.

1.2 SUBMITTALS

A. Quality Control Submittals: Written procedures for maintaining and markup of record documents.

B. Contract Close-out Submittals: Submit prior to application for final payment.

1. Record Documents: As required in the General Conditions.
2. Approved Shop Drawings and Samples: As required in the General Conditions.
3. Special Bonds, Special Warranties, and Service Agreements.
4. Consent of Surety to Final Payment: As required in the General Conditions.
5. Releases or Waivers of Liens and Claims: As required in the General Conditions.
6. Releases from Agreements.
7. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01025, MEASUREMENT AND PAYMENT.
8. Spare Parts and Special Tools: As required by individual specification sections.
9. Final Payrolls.
10. Release of Claims.
11. Pay Request Certification.
12. Government Inspection and Acceptance.

1.3 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each page of Specifications and each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of Work, both concealed and visible, to enable future modification of Work to proceed without lengthy and expensive site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in Work has occurred.
4. Prior to submitting each request for progress payment, request COTR/CM's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a referral by COTR/CM to recommend the whole or any part of the CONTRACTOR's Application for Payment, either partial or final.

1.4 RELEASES FROM AGREEMENTS

A. Furnish Contracting Officer written releases from property owners or public agencies where side agreements or special easements have been made, or where CONTRACTOR's operations have not been kept within the GOVERNMENT's construction right-of-way.

B. In the event CONTRACTOR is unable to secure written releases, inform the Contracting Officer of the reasons:

1. Contracting Officer/COTR will examine the site, and Contracting Officer will direct CONTRACTOR to complete Work that may be necessary to satisfy terms of the easement.
2. Should CONTRACTOR refuse to perform this Work, Contracting Officer reserves the right to have it done by separate contract and deduct the cost of same from the Contract Price, or require the CONTRACTOR to furnish a satisfactory Bond in a sum to cover legal claims for damages.
3. When Contracting Officer is satisfied that Work has been completed in agreement with the Contract Documents and terms of easements, the right is reserved to waive the requirement for written release if:

(i) CONTRACTOR's failure to obtain such statement is due to the grantor's refusal to sign, and this refusal is not based upon any legitimate claims that CONTRACTOR has failed to fulfill the terms of the easement, or (ii) CONTRACTOR is unable to contact or has had undue hardship in contacting the grantor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. GOVERNMENT will provide CONTRACTOR one complete set of Contract Documents, at pre-Construction conference..
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.
4. The record drawings shall indicate, in addition to all changes and corrections, the actual location of all subsurface utility lines. In order for the location of these lines and appurtenances to be determined in the event the surface openings or indicators become covered or obscured, the record drawings shall show, by offset dimensions to two permanently fixed surface features, the end of each run including each change in direction. Valves, splice boxes, and similar appurtenances shall be located by dimensioning along the utility run from a reference point. The average depth below the surface of each run shall also be recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by COTR/CM.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.

3) Blue and circled in blue to show notes.

2. Date entries.
3. Call attention to entry by "cloud" drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
   d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   e. Changes made by Request For Information, Change Order/ Modification, and COTR/CM's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
   b. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.

3.2 FINAL CLEANING

A. At completion of Work or immediately prior to CONTRACTOR's notice of completion, clean entire site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Contracting Officer/COTR/CM.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.

6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Remove snow and ice from access to buildings.
10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
11. Leave water courses, gutters, and ditches open and clean.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 02050
DEMOLITION

PART 1 GENERAL

1.1 WORK SCOPE

A. Items to be demolished are as follows and as shown on the Drawings:

1. Buried utility pipes, ducts, conduits, etc., that are in the path of new construction or as otherwise shown.

B. Utilities to be abandoned as shown on the Drawings.

C. Disposal of all demolition debris and final site cleanup.

1.2 SUBMITTALS

A. Quality Control Submittals: Copies of any authorizations and permits required to perform Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Utilities:

1. Notify OWNER or appropriate utilities to turn off affected services before starting demolition or abandonment.
2. Remove utility lines exposed by demolition excavation.
3. Plug sewerlines at locations shown or at limits of excavation if not shown with concrete length of plug, 5 feet minimum to prevent groundwater infiltrating sewer systems.

3.2 DEMOLITION

A. Remove piping from areas to be backfilled. Pipe, valves, and fittings adjacent to those to be removed may also be removed as salvage.

B. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.

3.3 DISPOSAL

A. Dispose of debris and other nonsalvaged materials offsite in licensed landfills.

3.4 BACKFILLING

A. Demolished Areas: Backfill to existing ground level or foundation level of new construction.

B. Backfill Material and Compaction:

1. Conform to Section 02220, FILL AND BACKFILL.
2. Do not use demolition debris as backfill material.

END OF SECTION

SECTION 02100
SITE PREPARATION

PART 1 GENERAL

1.1 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

C. Stripping: Removal of topsoil remaining after applicable scalping is completed.

D. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.2 SCHEDULING AND SEQUENCING

A. Prepare site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 2 acres.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Scalp and strip areas actually needed for waste disposal, borrow, or site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.2 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation 5 feet beyond top of cut slopes.
2. Fill:
   a. Stripping and Scalping: 2 feet beyond toe of permanent fill.
3. Structures: 15 feet outside of new structures.
4. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.3 SCALPING

A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.

B. Scalp areas within limits shown or specified.

3.4 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stockpile strippings, meeting requirements of Section 02920, SOIL PREPARATION, for topsoil, separately from other excavated material.

3.5 DISPOSAL

A. Scalpings:

1. Dispose of debris offsite.
2. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 02140
DEWATERING

PART 1 GENERAL

1.1 GENERAL

A. During subsurface exploration groundwater was encountered 10 feet below the existing ground surface at the time the boring was made.

1.2 SUBMITTALS

A. Administrative Submittals:

1. Well permits.
2. Discharge permits.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Remove and control water during periods when necessary to properly accomplish Work.

3.2 SURFACE WATER CONTROL

A. See Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS, Article TEMPORARY CONTROLS.

B. Remove surface runoff controls when no longer needed.

3.3 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed work, or adjacent property.
3. To relieve artesian pressures and resultant uplift of excavation bottom.

3.4 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.5 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

END OF SECTION

SECTION 02205
EXCAVATION

PART 1 GENERAL

1.1 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.2 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.3 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02050, DEMOLITION, prior to excavating.

B. Scalping and Stripping: Complete applicable Work specified in Section 02100, SITE PREPARATION, prior to excavating.

C. Dewatering: Conform to applicable requirements of Section 02140, DEWATERING, prior to initiating excavation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1-foot except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of COTR/CM.

C. Remove or protect obstructions as shown and as specified in Section 01500, CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS, Article PROTECTION OF WORK AND PROPERTY.

3.2 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.4 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.

3.5 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.6 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Dispose of debris resulting from removal of underground facilities as specified in Section 02050, DEMOLITION, for demolition debris.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 02100, SITE PREPARATION, for clearing and grubbing debris.

END OF SECTION

CCCTION 02215
SUBGRADE PREPARATION

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. D698, Standard Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 5.5-pound (2.49 kg) Rammer and 12-inch (305 mm) Drop.
   b. D1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-pound (4.54 kg) Rammer and 18-inch (457 mm) Drop.

1.2 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 02220, FILL AND BACKFILL.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 02220, FILL AND BACKFILL.

D. Relative Density: As defined in Section 02220, FILL AND BACKFILL.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

F. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.3 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 02050, DEMOLITION; 02100, SITE PREPARATION; and 02205, EXCAVATION, prior to subgrade preparation.

1.4 QUALITY ASSURANCE

A. Notify COTR/CM when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.2 COMPACTION

A. Under Earthfill: Three passes with three-wheeled power roller weighing approximately 10 tons.

B. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Three passes with a loaded dump truck or similar heavy-wheeled vehicle.

3.3 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.4 TESTING

A. Proof-roll subgrade with equipment specified in Article COMPACTION to detect soft or loose subgrade or unsuitable material, as determined by COTR/CM.

3.5 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact, or
2. Over excavate as specified in Section 02205, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 02220, FILL AND BACKFILL.

B. Unsuitable Material: Over excavate as specified in Section 02205, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 02220, FILL AND BACKFILL.

END OF SECTION

SECTION 02220
FILL AND BACKFILL

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 5.5-pound (2.49 kg) Rammer and 12-inch (305 mm) Drop.
   e. D1556, Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
   f. D1557, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-pound (4.54 kg) Rammer and 18-inch (457 mm) Drop.
   g. D2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods.
   h. D4253, Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
   i. D4254, Standard Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.

1.2 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by COTR/CM.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Geosynthetics: Geotextiles, geogrids, or geomembranes.

H. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1-foot outside outermost edge at base of foundations or slabs.
2. 1-foot outside outermost edge at surface of roadways or shoulder.
3. 0.5-foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near site.

K. Selected Backfill Material: Materials available onsite that COTR/CM determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources offsite, suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

O. Standard Specifications: When referenced in this section, shall mean Illinois Department of Transportation Standard Specifications.

1.3 SUBMITTALS

A. Samples: Imported material taken at source.

B. Quality Control Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.4 QUALITY ASSURANCE

A. Notify COTR/CM when:

1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.5 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 02050, DEMOLITION; 02100, SITE PREPARATION; 02205, EXCAVATION; and 02215, SUBGRADE PREPARATION, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03301, REINFORCED CONCRETE. Obtain COTR/CM's acceptance of concrete work and attained strength prior to placing backfill.

C. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 02215, SUBGRADE PREPARATION.

PART 2 PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.
2. During production of imported material, test as follows:
   a. Granular Fill: 1 per 2,000 cubic yards, minimum 3.
   b. Base Course Rock: 1 per 2,000 cubic yards, minimum 3.
   c. Foundation Stabilization Rock: 1 per 2,000 cubic yards, minimum 3.

2.2 EARTHFILL

A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.

C. Provide imported material of equivalent quality, if required to accomplish Work.

2.3 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well-Graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.4 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.5 BASE COURSE ROCK

A. As specified in Section 02236, BASE COURSE.

2.6 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

B. Uniformly graded from coarse to fine.

C. Free from excessive dirt and other organic material.

D. Maximum 2-1/2 inches particle size.

PART 3 EXECUTION

3.1 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 02225, TRENCH BACKFILL.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 02225, TRENCH BACKFILL, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.2 FILL OR BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D698.

B. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 98 percent relative compaction as determined in accordance with ASTM D698.

3.3 FILL

A. Outside Influence Areas Beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

1. Allow for 6-inch thickness of topsoil where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to minimum 95 percent relative compaction as determined in accordance with ASTM D698.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.4 SITE TESTING

A. Gradation:

1. One sample from each 1,500 tons of finished product or more often as determined by COTR/CM, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D2922. During placement of materials, test as follows:

1. Granular Fill: 1 per acre, minimum 1 per lift.
2. Base Course Rock: 1 per acre, minimum 1 per lift.
3. Foundation Stabilization Rock: 1 per acre, minimum 1 per lift.

3.5 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by COTR/CM as follows:

1. Beneath Footings: Granular fill.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.

4. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 02225, TRENCH BACKFILL.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 02225, TRENCH BACKFILL.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run:Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited unless, in COTR/CM's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earth fill.

3.6 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 02236, BASE COURSE.

END OF SECTION

SECTION 02225
TRENCH BACKFILL

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): Z53.1, Safety Color Code.
2. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.
3. American Society for Testing and Materials (ASTM):
   a. C33, Standard Specification for Concrete Aggregates.
   b. C94, Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Sieve Analysis of Fine and Coarse Aggregates.
   e. C150, Portland Cement.
   f. C618, Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
   g. D422, Method for Particle-Size Analysis of Soils.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/cubic ft)(600 Kn-m/cubic m).
   i. D1140, Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/cubic ft)(2,700 Kn-mm/cubic m).
   k. D3776, Mass per Unit Area (Weight) of Woven Fabric.
   l. D3786, Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.
   m. D4253, Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
   n. D4254, Standard Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.
   o. D4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   p. D4533, Trapezoid Tearing Strength of Geotextiles.
   q. D4832, Preparation and Testing of Soil-Cement Slurry Test Cylinders.

r. D4991, Leakage Testing of Empty Containers by Vacuum Method.
s. D5034, Breaking Force and Elongation of Textile Fabrics (Grab Test).

1.2 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by the CONTRACTOR from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the COTR/CM.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available onsite that COTR/CM determines to be suitable for a specific use.

J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.3 SUBMITTALS

A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Samples:

1. Trench stabilization material.
2. Bedding and pipe zone material.
3. Granular backfill.
4. Earth backfill.
5. Sand(s).

C. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.

1. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.

PART 2 PRODUCTS

2.1 MARKING TAPE

A. Plastic:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 4 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Allen; Markline.

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 5.5 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
6. Manufacturers and Products:
   a. Reef Industries; Terra ”D”.
   b. Allen; Detectatape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color[a]	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Water, irrigation, and slurry lines

[a]As specified in ANSI Z53.1, Safety Color Code.

2.2 TRENCH STABILIZATION MATERIAL

A. Base Rock:

1. Clean, hard, durable 3-inch minus crushed rock or gravel, or pit run, free from clay balls, other organic materials, or debris.
2. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping, and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18 Inches Diameter: 3/4-inch maximum particle size, except 1/4-inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 inches diameter.
4. Pipe Greater than 18 Inches Diameter: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.

5. Conduit and Direct-Buried Cable:
   a. Sand, clean or clean to silty, less than 12 percent passing the No. 200 sieve.
   b. Individual Particles: Free of sharp edges.
   c. Maximum Size Particle: Pass a No. 4 sieve.
   d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.4 EARTH BACKFILL

A. Soil, loam, or other excavated material suitable for use as backfill.

B. Free from roots or organic matter, refuse, boulders and material larger than 1/2 cubic foot, or other deleterious materials.

2.5 TOPSOIL

A. As specified in Section 02920, SOIL PREPARATION.

2.6 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Earth backfill, including specified class(es).
2. Trench stabilization material.
3. Bedding and pipe zone material.

PART 3 EXECUTION

3.1 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.2 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify COTR/CM. COTR/CM will determine depth of overexcavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

A. Furnish imported bedding material where, in the opinion of COTR/CM, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: As follows:

1. Pipe, 15-inch and Smaller: 4 inches.
2. Pipe, 18-inch to 36 inch: 6 inches.
3. Pipe, 42-inch and Larger: 8 inches.
4. Conduit: 3 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipes 10 Inches and Smaller Diameter: First lift less than or equal to 1/2 pipe-diameter.
2. Pipes Over 10 Inches Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

F. Do not use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, at depth of 2 feet. Coordinate with piping installation drawings.

1. Metallic Marking Tape: Install with nonmetallic piping and waterlines.
2. Plastic Marking Tape: Install with metallic piping.

3.7 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

B. Under Facilities: Backfill trench above pipe zone with granular backfill in loose lifts not exceeding 8 inches. Compact to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

C. Other Areas:

1. Place Earth Backfill in loose lifts not exceeding 9-inch thickness.
2. Mechanically compact each lift to minimum of 90 percent relative compaction prior to placing succeeding lifts.

3.8 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench.

B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.9 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

B. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

C. Concrete Pavement: Replace settled slabs.

D. Asphaltic Pavement: Replace settled areas or fill with asphalt.

E. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 02236
BASE COURSE

PART 1 GENERAL

1.1 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform surface reasonably true to cross-section.

C. Standard Specifications: Standard Specifications for Road and Bridge Construction, Adopted January 1, 1997, Illinois Department of Transportation.

1.2 SUBMITTALS

A. Samples: Submit for specified materials 15 days prior to delivery to site.

B. Quality Control Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial laboratory 15 days prior to delivery of materials to project.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE

A. As specified for Coarse Aggregate, Article 1004.04 of the Standard Specifications.

2.2 SOURCE QUALITY CONTROL

A. CONTRACTOR: Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on materials' test results on installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. As specified in Section 02215, SUBGRADE PREPARATION.

B. Obtain COTR/CM's acceptance of subgrade before placement of course aggregate.

C. Do not place base materials on soft, muddy, or frozen subgrade.

3.2 EQUIPMENT

A. In accordance with Section 351.05 of the Standard Specifications.

B. Compaction Equipment: Adequate in design and number to provide compaction and obtain the specified density for each layer.

3.3 HAULING AND SPREADING

A. Hauling and Spreading: In accordance with Section 351.03 of the Standard Specifications.

3.4 CONSTRUCTION OF COURSES

A. Construction of Courses: In accordance with Article 351.05 of the Standard Specifications.

3.5 ROLLING AND COMPACTION

A. Rolling and Compaction: In accordance with Article 351.05 of the Standard Specifications.

3.6 FIELD QUALITY CONTROL

A. In-Place Density Tests: 1 per acre, minimum 1 per lift.

3.7 CLEANING

A. Remove excess material; clean stockpile areas of aggregate.

END OF SECTION

SECTION 02521
CONCRETE CURBS AND SIDEWALKS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Quality Control Submittals:

1. Curing Compound: Manufacturer's Certificate of Compliance and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Conform to IDOT Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

A. Conform to the requirements for Portland Cement Concrete, Section 1020 of the IDOT Specifications.

2.2 EXPANSION JOINT FILLER

A. Bituminous Preformed Joint Filler, as specified in Article 1051.03 and 424.07 of the IDOT Specifications.

2.3 CONCRETE

A. As specified in Section 03301, REINFORCED CONCRETE.

B. Maximum Aggregate Size: 1-1/2-inch.

C. Slump: 2 to 4 inches.

2.4 CURING COMPOUND

A. Liquid membrane-forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 EXECUTION

3.1 INSTALLATION

A. Perform Work in accordance with the applicable sections of the IDOT Specifications.

3.2 FORMWORK

A. Lumber Materials:

1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb and sidewalk.
2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:

1. Construct forms to shape, lines, grades, and dimensions.
2. Stake securely in place.

D. Bracing:

1. Brace forms to prevent change of shape or movement resulting from placement.
2. Construct short-radius curved forms to exact radius.

E. Tolerances:

1. Do not vary tops of forms from gradeline more than 1/8-inch when checked with 10-foot straightedge.
2. Do not vary alignment of straight sections more than 1/8-inch in 10 feet.

3.3 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of Article 606.05 (Concrete Curb and Gutter) and Article 424.06 (Concrete Sidewalk) of the IDOT Specifications, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.4 CURB CONSTRUCTION

A. Perform work in accordance with Articles 606.05 and 606.06 of the IDOT Specifications.

B. Construct ramps at pedestrian crossings.

C. Expansion Joints: Place at maximum 45-foot intervals and at the beginning and end of curved portions of curb, and at connections to existing curbs. Install expansion joint filler at each joint.

D. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.

E. Contraction Joints:

1. Maximum 15-foot intervals in curb.
2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.
3. Insert steel sheet to full depth of curb.
4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
5. Finish top of curb with steel trowel and finish edges with steel edging tool.

F. Front Face:

1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
3. Remove and replace *defective* concrete.
4. Apply curing compound to exposed surfaces of curb upon completion of finishing.
5. Continue curing for minimum of 5 days.

G. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.

1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
2. Compact backfill firmly.

3.5 SIDEWALK CONSTRUCTION

A. Thickness:

1. 4 inches in walk areas.
2. 6 inches in driveway areas.

B. Expansion Joints: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

C. Contraction Joints:

1. Provide transversely to walks at locations opposite contraction joints in curb.
2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
3. Construct straight and at right angles to surface of walk.

D. Finish:

1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
3. Apply curing compound to exposed surfaces upon completion of finishing.
4. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION

SECTION 02555
BITUMINOUS CONCRETE PAVEMENT

PART 1 GENERAL

1.1 DEFINITIONS

A. Combined Aggregate: All mineral constituents of an asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Standard Specifications: Standard Specifications for Road and Bridge Construction, adopted January 1, 1997, Illinois Department of Transportation.

1.2 SUBMITTALS

A. Samples: As specified in Article 406.04 of the Standard Specifications.

1. Compacted Asphalt Concrete: As specified in Article 406.16 of the Standard Specifications.
2. Uncompacted Asphalt Mixture: As specified in Article 406.15 of the Standard Specifications.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance for the following materials:
   a. Aggregate: Gradation.
   b. Asphalt for Binder: Type and grade.
   c. Prime Coat: Type and grade of asphalt.
   d. Mixes: Conforms to job-mix formula.
2. Manufacturer's Certificate of Proper Installation.
3. Statement of qualification for independent testing laboratory.
4. Test Results:
   a. Mix Design:
      1) Aggregate gradation.
      2) Asphalt content.
      3) Stability number.
   b. Asphalt Concrete Cores:
      1) Permeability.
      2) Density.
   c. Uncompacted Mix:
      1) Asphalt content.
      2) Aggregate gradation.
   d. Asphalt cement for binder.

1.3 QUALIFICATIONS

A. Independent Testing Laboratory: In accordance with ASTM E699.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Temperature: As specified in Article 406.04 of the Standard Specifications:

1. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

PART 2 PRODUCTS

2.1 AGGREGATE

A. As specified in Article 1003.03 and 1004.03 of Standard Specification for hot plant mix bituminous pavement.

2.2 PRIME COAT

A. Liquid asphalt, Grade MC-30 conforming to Section 1009 of Standard Specifications.

2.3 ASPHALT CEMENT

A. Asphalt cement to be used in the asphalt concrete mixture shall be Grade AC10 as specified in Section 1009 of Standard Specifications.

2.4 SOURCE QUALITY CONTROL

A. Tests: Furnish services of independent testing laboratory to conduct tests.

1. Job-Mix Formula for Pavements:
   a. Define gradation for each of the aggregate constituents used in mixture and establish exact proportion of each constituent to produce a gradation of aggregate within specified limits.
   b. Bulk specific gravity for each aggregate constituent.
   c. Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
   d. Properties as stated in Standard Specifications, Section 1009, for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
   e. Percent of asphalt lost due to absorption by aggregate.
   f. After each job-mix formula is established, the combined aggregate grading of respective mixture furnished to the Project shall meet tolerances specified in Article 406.10 of Standard Specifications.

PART 3 EXECUTION

3.1 GENERAL

A. Application Equipment: In accordance with Article 406.03 of Standard Specifications.

B. Shoulders: Construct to lines, grades, and cross-sections shown.

C. Traffic Control: CONTRACTOR shall be solely responsible for traffic control and for meeting all federal, state, and local requirements for such.

3.2 CONTROL OF LINE AND GRADE

A. Provide and maintain intermediate control, independent of the underlying base to meet finish surface grades and minimum thickness.

3.3 PRIME COAT

A. Construction Requirements as specified in Article 406.06b of the Standard Specifications.

3.4 ASPHALT CONCRETE PAVEMENT PLACEMENT

A. Lay asphalt concrete binder course over prepared base in two lifts of 2 inches and 1.5 inches, respectively, to a total compacted thickness of 3.5 inches. Surface courses not included in this Contract.

B. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

C. Apply tack coat to pavement surface prior to placing succeeding pavement lift.

3.5 CONNECTIONS WITH EXISTING FACILITIES

A. Where asphalt concrete pavement connects to an existing asphalt surface, modify existing roadway profile to produce a smooth riding connection to existing facility.

B. Modifying Existing Surfaces: Burn or chip existing paved surfaces to provide meet lines and surfaces. Allow for sufficient depth of removal to reinstall a minimum thickness of 1-inch of asphalt concrete.

1. Meet Lines: Lines straight and edges vertical.

2. Edges of Meet Line Cuts: Paint with tack coat prior to placing pavement.
3. Sealing Meet Line: After placement of pavement, by painting with liquid asphalt or emulsified asphalt, cover immediately with clean, dry sand.

C. Paint edges of contact surfaces (curbs, manhole frames), before laying pavement, with tack coat or paving asphalt cement to provide watertight joints. Do not stain adjacent surfaces not intended to be coated.

3.6 JOINTS

A. Offset edge of each layer a minimum of 6 inches so joints shall not be directly over those in underlying layer.

B. Offset longitudinal joints in roadway pavements, so longitudinal joints in wearing layer coincides with pavement centerlines and lane divider lines.

C. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer, as specified in Article 406.17 of the Standard Specifications.

3.7 COMPACTION

A. Roll until roller marks are eliminated and density of 93 to 97 percent of measured maximum density determined in accordance with AASHTO T209, as specified in Article 406.16 of the Standard Specifications is obtained.

3.8 FIELD QUALITY CONTROL

A. Field Density Tests:

1. Perform tests from cores or sawed Samples.
2. Measured with properly operating and calibrated nuclear density gauge.
3. Maximum Density: Determined in accordance with AASHTO T209, using a Sample of mix taken prior to compaction from the same location as the density test Sample.

END OF SECTION

SECTION 02580
PAVEMENT MARKING

PART 1 GENERAL

1.1 DEFINITIONS

A. Standard Specifications: Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation.

1.2 SUBMITTALS

A. Shop Drawings:

1. Product Data: Paint.
2. Description of proposed methods for removal of drips, overspray, improper markings, paint and debris tracked by traffic, and existing markings.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance for products specified in this section.
2. Equipment List: Proposed equipment to be used, including descriptive data.

PART 2 PRODUCTS

2.1 PAINT

A. In accordance with Article 811.02 of the Standard Specifications. Glass beads are not required.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Cleaning:

1. Thoroughly clean surfaces to be marked before application of pavement marking material. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods.
2. Completely remove rubber deposits, surface laitance, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion.

3. Allow pavement surfaces to dry, when water is used for cleaning, prior to striping or marking.
4. Reclean surfaces when Work has been stopped due to rain.

B. Layout of Markings: Unless previously applied markings are present to serve as a guide, layout markings in advance of paint application.

C. Pretreatment for Early Painting: Where early painting is required on rigid pavements, a pretreatment with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride shall be applied to prepared pavement areas prior to painting.

3.2 APPLICATION

A. General:

1. Comply with paint manufacturer's recommendations.
2. If paint is not factory mixed, thoroughly mix pigment and vehicle together prior to application, and keep thoroughly agitated during application.
3. Do not add thinner.
4. Apply to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Maintain paint temperature within these same limits.
5. Allow new asphalt pavement and portland concrete cement surfaces to cure for period of not less than 3 days before applications of paint.
6. Provide guide lines and templates to control paint application.
7. Take special precautions in marking numbers, letters, and symbols.
8. Apply paint only to pavement surfaces that are unfrozen, dry, and clean.
9. Edges of markings shall be sharply outlined.

B. Rate of Application: Apply paint at a uniform rate between 105 and 115 square feet per gallon per coat, without running or spattering.

C. Color: White.

D. Drying:

1. Provide maximum drying time of paint to prevent undue softening of bitumen, pickup, displacement, or discoloration by tires of traffic.
2. If there is a delay in drying of markings, discontinue painting operations until cause of slow drying is determined and corrected.

E. Features to be Painted:

1. Parking space markings.
2. Handicap parking space symbols, in accordance with the International Symbol of Accessibility as published in the Federal Register for the Americans with Disabilities Act.
3. Miscellaneous items as shown.

3.3 PROTECTION

A. Protect markings from traffic until paint is thoroughly dry.

B. Protect surfaces from disfiguration by paint spatters, splashes, spills, or drips.

3.4 CLEANUP

A. Remove paint spatters, splashes, spills, or drips.

END OF SECTION

SECTION 02683
DISINFECTION OF WATER SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. B300, Hypochlorites.
   b. B301, Liquid Chlorine.
   c. B303, Sodium Chlorite.
   d. C651, Disinfecting Water Mains.
   e. C652, Disinfection of Water-Storage Facilities.
   f. C653, Disinfection of Water Treatment Plants.
   g. C654, Disinfection of Wells.

1.2 QUALITY CONTROL SUBMITTALS

A. Procedures and plans for disinfection and testing.

B. Type of disinfecting solution and method of preparation.

C. Training records for employees working with concentrated chlorine solutions or gas.

D. Method of disposal for disinfecting wastewater.

1.3 QUALIFICATIONS

A. Independent Testing Agency: 10 years' experience in the field of water sampling and testing required for this Project. Calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

1.4 SEQUENCING AND SCHEDULING

A. Commence initial disinfection after completion of following:

1. Completion and acceptance of internal painting of system(s).
2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.

3. Disinfection of:
   a. Pumps and associated system piping.
   b. Treatment plant basins and processes used to supply water to system.

PART 2 PRODUCTS

2.1 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable.

B. OWNER will supply potable quality water, CONTRACTOR shall convey in disinfected pipelines or containers.

2.2 CONTRACTOR'S EQUIPMENT

A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2.3 MIXING DISINFECTANT

A. Prepare “stock” solution by mixing any of following as described below. The purpose of the stock solution is to facilitate mixing and dilution to ensure a uniform disinfecting solution. The CONTRACTOR will not be required to mix a stock solution if a liquid chlorine gas feed system that can accurately feed a desired amount of chlorine to mix a final (dilute) disinfecting solution is used.

   1. Liquid chlorine gas conforming to AWWA B301 and water mixture.
   2. Dry chlorine gas conforming to AWWA B301.
   3. Calcium hypochlorite conforming to AWWA B300 or sodium hypochlorite conforming to AWWA B303 powder or liquid and water mixture.

B. Feed dry chlorine gas through devices to regulate the rate of flow and ensure uniform diffusion of gas into water within the pipe or vessel being treated. Chlorinating devices for feeding chlorine gas solution or the gas itself shall prevent backflow of water into chlorine cylinder.

C. Use following proportions of hypochlorite or chlorine to water:

   1. Chlorine Gas or Liquid (100 Percent Cl): 1 pound per 11.75 gallons water.
      a. Apply liquid chlorine gas-water solution by means of a solution feed chlorinating device.

2. Calcium Hypochlorite (65 to 70 Percent Cl): 1 pound per 7.5 gallons water.
   a. If calcium hypochlorite is used, first mix dry powder with water to make a thick paste, then thin to a 1 percent solution (10,000 ppm chlorine).
3. Sodium Hypochlorite (5.25 Percent Cl): 1 gallon per 4.25 gallons water.
   a. If sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution.

PART 3 EXECUTION

3.1 GENERAL

A. Disinfect the following pipelines, installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. W1.
2. Disinfect new pipelines that connect to existing pipelines up to the point of connection.
3. Disinfect surfaces of materials that will contact finished water, both during and following construction using spray method described below. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

B. Prior to application of disinfectants, clean tanks, equipment, and pipelines of loose and suspended material. Flush pipelines until clear of suspended solids and color. Use water suitable for flushing and disinfecting.

C. Conform to AWWA C651 for pipes and pipelines, C652 for tanks and reservoirs, and AWWA C654 for wells, except as modified in these Specifications.

D. Allow freshwater and stock disinfectant solution to flow into the pipe or vessel at a measured rate so that the chlorine-water solution is at the specified strength. Do not place concentrated commercial disinfectant in the pipeline or vessel before it is filled with water.

3.2 PIPING

A. Flushing:

1. Before disinfecting, flush all foreign matter from pipeline. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe, where it is impractical or impossible to flush the pipe at specified velocity, clean

the pipeline in-place from the inside by brushing and sweeping, then flush the line.

2. Flush pipelines through flushing branches and remove branches after flushing is completed. Operate valves during flushing process at least twice during each flush.
3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections.

B. Disinfecting Solution: Chlorine-water solution having a free chlorine concentration of not less than 50 ppm.

C. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

D. Point of Application:

1. Inject chlorine mixture into pipeline to be treated at beginning of line through corporation stop or suitable tap in top of pipeline.
2. Control water from existing system to flow slowly into pipeline during application of chlorine.
3. Control rate of chlorine solution flow in proportion to rate of water entering pipe so that combined mixture shall contain not less than 50 ppm of free available chlorine.
4. Prevent backflow of chlorine solution into line supplying water.

E. Retention Period:

1. Retain treated water in pipeline for at least 24 hours to destroy all nonspore-forming bacteria. At end of 24 hour period, disinfecting solution shall contain at least 10 ppm of free chlorine or the pipeline shall be recleaned, disinfecting solution shall be reapplied, and specified procedure repeated.
2. Operate valves, hydrants, and appurtenances during disinfection to ensure that disinfecting solution is dispersed into all parts of pipeline, including dead-ends and areas that otherwise may not be treated.
3. After disinfection, flush water from the permanent source until water through the pipeline is equal chemically and bacteriologically to permanent source of supply. Flushing of service connections after chlorination is not required.

3.3 DISPOSAL OF DISINFECTING WASTEWATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.

1. See AWWA C652 for acceptable neutralization methods.

3.4 TESTING

A. Test Equipment:

1. Clean containers and equipment used in sampling and assure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from an independent testing laboratory.

END OF SECTION

SECTION 02920
SOIL PREPARATION

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Product labels/data sheets.

B. Samples: Representative of stockpiled or imported topsoil.

C. Quality Control Submittals:

1. Certified Topsoil Analysis Reports:
   a. Indicate quantities of materials necessary to bring topsoil into compliance with textural/gradation requirements.
   b. Indicate quantity of lime, and quantity and analysis of fertilizer.

1.2 SEQUENCING AND SCHEDULING

A. Perform Work specified in Section 02100, SITE PREPARATION, prior to performing Work specified under this section.

PART 2 PRODUCTS

2.1 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Composition: As determined in accordance with USBR 514.4.4:

1. Gravel-Sized Fraction: Maximum 10 percent by weight retained on a No. 10 sieve.
2. Sand-Sized Fraction: Maximum 65 percent passing No. 10 sieve and retained on No. 270 sieve.
3. Silt-Sized Fraction: Maximum 50 percent passing No. 270 sieve and larger than 0.002 millimeter.
4. Clay-Sized Fraction: Maximum 25 percent smaller than 0.002 millimeter.

C. Organic Matter: Minimum 1.5 percent by dry weight as determined in accordance with USBR 514.8.7.

D. pH: Range 6.0 to 7.2.

E. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.

F. Source: Stockpile material onsite, in accordance with Section 02100, SITE PREPARATION. Import topsoil if onsite material fails to meet specified requirements or is insufficient in quantity.

2.2 LIME

A. Composition: Ground limestone with not less than 85 percent total carbonates, ASTM C602.

B. Gradation:

1. Minimum 50 percent passing No. 100 sieve.
2. Minimum 90 percent passing No. 20 sieve.
3. Coarser material acceptable provided rates of application are increased proportionately on basis of quantities passing No. 100 sieve.

2.3 SAWDUST OR GROUND BARK

A. Nontoxic, of uniform texture, and subject to slow decomposition when mixed with soil. Nitrogen-treated, or if untreated mix with minimum 0.15 pounds of ammonium nitrate or 0.25 pounds of ammonium sulfate per cubic foot of loose material.

2.4 PEAT

A. Composition: Natural residue formed by decomposition of reeds, sedges, or mosses in a freshwater environment, free from lumps, roots, and stones.

1. Organic Matter: Not less than 90 percent on a dry weight basis as determined by USBR 514.8.7.
2. Moisture Content: Maximum 65 percent by weight at time of delivery.

2.5 FERTILIZER

A. Manure: Well-rotted, stable or cattle manure, free from weed seed and refuse. Maximum 50 percent sawdust or shavings by volume.

1. Age: Minimum 4 months; maximum 2 years.

2.6 SAND

A. Fine Aggregate: Clean, coarse, well-graded, ASTM C33.

2.7 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

B. Remove stones over 3/4 inch in any dimension, sticks, roots, rubbish, and other extraneous material.

C. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.2 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

B. Mix soil amendments, lime, and fertilizer with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding. Delay mixing of fertilizer if planting or seeding will not occur within 3 days.

C. Place 1/2 of total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth as shown after compacting to 75 percent where seeding and planting are scheduled.

D. Uniformly distribute to within 1/2-inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

E. Remove stones exceeding 3/4 inch, roots, sticks, debris, and foreign matter during and after topsoil placement.

F. Remove surplus subsoil and topsoil from site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

END OF SECTION

SECTION 02936
SEEDING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Seeding or Hydroseeding, mulching and fertilizing.

B. Maintenance.

1.2 RELATED SECTIONS

A. Section 02205, EXCAVATION.

B. Section 02220, FILL AND BACKFILL.

C. Section 02225, TRENCH BACKFILL.

D. Section 02920, SOIL PREPARATION.

E. Section 02950, TREES, PLANTS AND GROUND COVER.

1.3 REFERENCES

A. FS O-F-241—Fertilizers, Mixed, Commercial.

1.4 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, Brome Grass, and other undesirable vegetation.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Section 01700, CONTRACT CLOSEOUT: Procedures for submittals.

B. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.6 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.7 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Section 01600, MATERIALS AND EQUIPMENT.

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.9 MAINTENANCE SERVICE

A. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition for three cuttings.

PART 1 PRODUCTS

2.1 SEED MIXTURE

A. Seed Mixture Type A: Thin-bladed Fescue mixture shall contain fresh, clean, new-crop seed with a minimum purity of 98 percent and minimum germination of 85 percent. The seed mixture (by weight) shall be 90 percent improved thin-bladed Fescue and 10 percent Rye grass. This mix shall be applied at the rate of 8 pounds per 1,000 square feet.

2.2 TOPSOIL

A. As specified in Section 02920, SOIL PREPARATION.

2.3 ACCESSORIES

A. Anti-Erosion Mulch: Provide clean, seed-free salt hay or threshed straw of wheat, rye, oats or barley. Apply at the rate of 2 tons per acre.

B. Wood Fiber Mulch Tackifier: Provide "Hydro-Stik hydrophilic colloid gum based tackifier or equal to anchor the straw/hay mulch. Apply at rate recommended by manufacturer (but not less than 30 pounds of binder with 800 gallons of water unless approved by COTR/CM) for use as an over spray on straw mulch. Apply with hydraulic equipment suitable for mixing and applying uniform mixture of tackifier.

C. Fertilizer: FS O-F-241, Fertilizer for seeded lawns shall be a commercial product recommended for grass, with fifty percent of the elements derived from organic sources; which when applied will supply the quantity of actual Nitrogen (N), available phosphoric acid (P_2O_5) percent, soluble potash (K_2O). Materials may be accepted on the basis of bag label analysis, or supplier's certification, or certified laboratory sample test. Application rates for lawn fertilizer shall be:

1. Initial or Seeding Application—this application should include the following amounts:
   a. 1 pound of actual Nitrogen (N) per 1,000 square feet
   b. 1.5 pound of P_2O_5 per 1,000 square feet.
   c. 8 pound of K_2O per 1,000 square feet.
2. Maintenance Application—Applied after third cutting, this application should include the following amounts of actual nutrients. It is the CONTRACTOR's responsibility not to burn or damage the lawn grasses or other plantings.
   a. 1.0 pound of actual Nitrogen (N) per 1,000 square feet
   b. 1.0 pound of P_2O_5 per 1,000 square feet.
   c. 1.0 pound of K_2O per 1,000 square feet.

D. Water: Clean, fresh and free of substances or matter, which could inhibit vigorous growth of grass.

E. Erosion Fabric: SC150 BN—100 percent Biodegradable Double Net Straw and Coconut Fiber Erosion Control Blanket manufactured by North American Green.

F. Stakes for erosion control blanket: The erosion control material is anchored with "U" shaped 11-gauge wire staples.

G. Anti-Erosion Mulch: Provide clean, seed-free salt hay or threshed straw of wheat, rye, oats or barley. Apply at the rate of 2 tons per acre.

H. Wood Fiber Mulch Tackifier: Provide "Hydro-Stik hydrophilic colloid gum based tackifier or equal to anchor the straw/hay mulch. Apply at rate recommended by manufacturer (but not less than 30 pounds of binder with 800 gallons of water unless approved by COTR/CM) for use as an over spray on straw mulch. Apply with hydraulic equipment suitable for mixing and applying uniform mixture of tackifier.

I. Hydro Mulch Fibers: Provide "Conwed Hydro Mulch 2000 Fibers with Tackifier, or equal." The mulch materials shall consist of virgin wood fibers manufactured expressly from whole wood chips. The chips shall be processed in such a manner as to contain no growth or germination inhibiting factors. Tackifier shall be a Colloidal Polysaccharide type adhered to the fibers during manufacturing. Application rate: 2,000 lbs. of mulch per acre.

2.4 TESTS

A. Submit minimum of eight (8) 10 oz. samples of "in-place" topsoil taken from eight (8) areas within the project area. Forward sample to an approved testing laboratory in sealed containers to prevent contamination.

PART 2 EXECUTION

NOTE: CONTRACTOR has the option of drill seeding or hydroseeding.

3.1 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this section. Required topsoil placement is described in Section 02920, SOIL PREPARATION.

B. Verify that required underground irrigation system is installed in proper location, and ready for use. Coordinate with installation of landscape plant materials.

C. Verify location of all underground utilities and coordinate to make sure planting operations does not disturb them.

D. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated soil.

3.2 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions at rate specified in Part 2 Materials of this section.

B. Apply after smooth raking of topsoil (and prior to roller compaction).

C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

D. Mix thoroughly into upper 2 inches of topsoil.

E. Lightly water to aid the dissipation of fertilizer.

3.3 SEEDING NEW LAWNS

A. Sow seed (at the rates specified in materials section for each seed mix), using either the mechanical drill seeding method or the hydro-seeding method. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.

B. Mechanical Drill Seeding Method:

1. Sow seed using mechanical power drawn drills or other approved seeding machine, which places seed into the soil. Markers or other means shall be provided to insure that the successive seeded strips will overlap or be separated by a space no greater than equipment row spacing. Drill seeding shall be accomplished with drills set no more than 6 inches apart. Hand broadcasting shall be limited to areas not accessible with other equipment. Seed mixture shall be sown at the rate of 7 pounds per 1,000 square feet.
2. All seeding is to be done in dry or moderately dry soil, and at times when wind velocity does not exceed 5 miles per hour. Distribute seed evenly over entire areas by sowing an equal quantity in two directions at right angles to each other. Final direction of sowing shall be done perpendicular to the ground slope.
3. Seed shall be covered by soil to an average depth of 1/4 to 3/8 inch by an approved method.
4. Protect seeded areas against erosion by spreading specified lawn mulch after completion of seeding operations. Spread uniformly to form a continuous blanket not less than 1-1/2-inch loose measurement over seeded areas.
5. Anchor mulch by one of the two methods listed below:
   a. Crimping the straw into the soil by shallow disking.
   b. Spraying with Wood Fiber Mulch Tackier at the rate of 4 to 6 gallons per 1,000 sq. ft. Take precautions to prevent damage or staining of construction or other plantings adjacent to mulched areas.

C. Hydroseeding New Lawns:

1. Mix specified seed, fertilized and pulverized mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.
2. Apply slurry uniformly to all areas to be seeded. Rate of application as required to obtain specified seed sowing rate.

D. Planting Season: Spring—March 1 through May 15; Fall—August 25 through October 15.

E. Do not sow immediately following rain, when ground is too dry, or during windy periods.

F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.4 SEED PROTECTION

A. Cover seeded slopes where grade is 1:3 or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.

B. Lay fabric smoothly on surface, bury top end of each section in 6-inch (150 mm) deep excavated topsoil trench. Provide 12-inch (300-mm) overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

C. Secure outside edges and overlaps at 36-inch (900-mm) intervals with stakes.

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches (150 mm).

3.5 MAINTENANCE

A. Mow grass at regular intervals to maintain at a maximum height of 3 inches. Do not cut more than 1/3 of grass blade at any one mowing. Do not mow when grass is wet. If mowing causes clogging or any matting of grass, rake the lawn clippings and remove.

B. Neatly trim edges and hand clip where necessary.

C. Immediately remove clippings after mowing and trimming.

D. Water to prevent grasses and soil from drying out.

E. Roll surface to remove minor depressions or irregularities.

F. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

G. Immediately reseed areas which show bare spots.

H. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

SECTION 02950
TREES, PLANTS, AND GROUND COVER

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Preparation of Plant Bed soil mix.

B. New trees, shrubs, perennials and ground cover plants.

C. Mulch and fertilizer.

D. Maintenance.

E. Tree Pruning.

1.2 RELATED SECTIONS

A. Section 02205, EXCAVATION.

B. Section 02220, FILL AND BACKFILL.

C. Section 02225, TRENCH BACKFILL.

D. Section 02920, SOIL PREPARATION.

E. Section 02936, SEEDING.

1.3 REFERENCES

A. ANSI Z60.1, American Standard for Nursery Stock.

1.4 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, Brome Grass and any plant life not specified

B. Plants: Living trees, plants, and ground cover specified in this Section , and described in ANSI Z60.1.

1.5 SUBMITTALS—PROJECT CLOSEOUT

A. Submit list of plant life sources.

B. Maintenance Data: Include cutting and trimming method; types, application frequency, recommended coverage of fertilizer; and watering recommendations.

1.6 QUALITY ASSURANCE

A. Substitutions and Product Options: Product options permitted in accordance with Section 01630, Substitutions and Product Options. Plant material substitutions not permitted without written authorization, and only after CONTRACTOR verification of "non-availability" of plant material within a 300-mile radius from the project site.

B. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.

C. Landscape Contractor / Installer Qualifications: Company specializing in installing and planting the plants with three (3) years documented experience.

D. Maintenance Services: Performed by installer during maintenance period.

1.7 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01600, MATERIAL AND EQUIPMENT.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

C. Protect and maintain plant life until planted.

D. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install plant life when ambient temperatures may drop below 32 degrees F or rise above 90 degrees F.

B. Do not install plant life when wind velocity exceeds 30 mph.

1.10 COORDINATION

A. Coordinate work under provisions of Section 01040, COORDINATION.

1.11 WARRANTY

A. Provide 100 percent replacement warranty for one year, defined as one continuous growing season; replace dead or unhealthy plants.

B. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

1.12 MAINTENANCE SERVICE

A. Maintain plant life for three months after Date of Substantial Completion.

B. Maintenance to include:

1. Cultivation and weeding plant beds and tree pits.
2. Applying herbicides for weed control in accordance with manufacturer's instructions. Remedy damage resulting from use of herbicides.
3. Remedy damage from use of insecticides.
4. Irrigating sufficient to saturate root system.
5. Pruning, including removal of dead or broken branches, and treatment of pruned areas or other wounds.
6. Disease control.
7. Maintaining wrapping, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.
8. Replacement of mulch in planting beds.

PART 2 PRODUCTS

2.1 TREES, PLANTS, AND GROUND COVER

A. Trees, shrubs, perennials and Ground Cover: Species and size identifiable in plant schedule, grown in climatic conditions similar to those in locality of the Work and meeting requirements of ANSI Z60.1.

B. COTR/CM may review selected plant materials at place of growth to verify acceptability.

2.2 TOPSOIL MATERIALS

A. Topsoil: As specified in Section 02920, SOIL PREPARATION.

2.3 SOIL AMENDMENT MATERIALS

A. Fertilizer: Shrubs & Trees shall be fertilized with commercially manufactured tablets and/or packets containing 21 grams of slow release fertilizer (ureaformaldehyde base) with 5 percent Nitrogen, 10 percent phosphoric acid and 5 percent soluble potash. Ground Cover and Perennial Planting Beds, shall be fertilized with a commercially available product containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.

B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.

C. Bone Meal: Raw, finely ground, commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.

D. Lime: Ground limestone, dolomite type, and minimum 95 percent carbonates.

E. Water: Clean, fresh, and free of substances or matter, which could inhibit vigorous growth of plants.

F. Herbicide/Pesticide: As required and meeting regulations during maintenance period. Applied in conformance with manufacture instructions.

2.4 MULCH MATERIALS

A. Mulching Material: Shredded bark mulch for the planting beds and exercise stations shall be of hardwood species wood, shredded to a size of 1/2 inch to 3 inches, free of growth or germination inhibiting ingredients.

2.5 ACCESSORIES

A. Wrapping Materials: Tree wrap shall be two thicknesses of crinkled paper cemented together with a layer of bituminous material. Wrapping materials shall be a minimum of 4 inches in with and have a stretch factor of 33-1/3 percent. Twine for tying shall be lightly tarred medium or coarse sisal yarn.

B. Stakes: Softwood lumber, pointed end.

C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.

D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.

2.6 PLANT BED SOIL MIX

A. A uniform mixture of 1 part peat moss and 3 parts topsoil by volume.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that prepared subsoil and planters are ready to receive work. Required topsoil placement is described in Section 02920, SOIL PREPARATION.

B. Saturate soil with water to test drainage.

C. Verify that required underground irrigation system is installed in proper location, and ready for use.

D. Verify location of all underground utilities and coordinate to make sure planting operations does not disturb them.

E. Stake locations of tree and shrub plantings and obtain approval from COTR/CM prior to planting. (Notify COTR/CM 2 days before planting layout).

3.2 PREPARATION OF PLANTING BEDS

A. Remove any remaining foreign materials, weeds and undesirable plants and their roots. Remove any undesirable or contaminated subsoil.

B. Prepare planting bed areas by cultivating topsoil (placed as part of Landscape Grading operation) to a depth of 6 inches. Planting bed preparation should be completed only during dry weather and on dry unfrozen subgrade. Add peat moss at prescribed rate and repeat cultivation until the plant bed soil is thoroughly mixed. Grade and compact to uneven areas. Maintain profiles and contours. Rake smooth. Make changes in grade gradual. Blend slopes into level areas.

C. Dig planting pits 6 inches larger than plant root system.

3.3 FERTILIZING

A. For tree and shrub pits, apply fertilizer packets and/or tablets in accordance with manufacturer's instructions.

B. For ground cover and perennial planting bed areas, apply as a part of the plant bed mix preparations, and apply at a rate of 4 pounds per 100 square feet and mix thoroughly into upper 3 inches of plant bed soil mix.

C. Lightly water to aid the dissipation of fertilizer.

3.4 PLANTING

A. Place plants for best appearance for review and final orientation by COTR/CM.

B. Plants will be rejected if a ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

C. Set plants vertical.

D. Remove non-biodegradable root containers.

E. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches as indicated on drawings under each plant. Remove burlap, ropes, and wires, from the root ball.

F. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

G. Wrap deciduous shade and flowering tree trunks and place tree protectors.

3.5 MAINTENANCE

A. Neatly trim plants where necessary.

B. Immediately remove clippings after trimming.

C. Water to prevent soil from drying out.

D. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions.

E. Apply pesticides in accordance with manufacturer instructions.

END OF SECTION

MATERIAL APPROVAL SUBMITTAL

TO: (Contracting Officer)	FROM: (Contractor)	DATE:
CONTRACT NUMBER:	SUBMITTAL NUMBER:	SUBMITTAL: New ( ) Resubmittal ( )
PREVIOUS SUBMITTAL NUMBER:	PROJECT NUMBER:	

(To be completed by the Contractor)			Government Use Only				
Line No.	Specification Sect. Para No., Draw No.	Description of Material (Include type, model, mfg)	APP	APP W/ COMNT	DISAP	SEE REV	INT

By completing this form, the undersigned contractor certifies that the material complies with all specifications of the subject contract.

DATE	TYPE OR PRINT NAME AND TITLE	SIGNATURE

FOR GOVERNMENT USE ONLY

TO: COTR
DATE: SIGNATURE:
RECOMMENDATIONS: **( ) Approval ( ) Disapproval is indicated above & subject to comments on reverse**

TO: (Contracting Officer)
DATE: SIGNATURE:
RECOMMENDATIONS: **( ) Approval ( ) Disapproval is indicated above & subject to comments on reverse**
TO: (Contractor)
DATE: SIGNATURE:
( ) Approval ( ) Disapproval is indicated above & subject to comments on reverse

AF FORM 3000a

SECTION 03301
REINFORCED CONCRETE

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete for Buildings.
   b. 305R, Hot Weather Concreting.
   c. 306R, Cold Weather Concreting.
   d. 318/318R, Building Code Requirements for Reinforced Concrete.
   e. 347, Formwork for Concrete.
2. American Society for Testing and Materials (ASTM):
   a. A497, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
   b. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   c. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   d. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   e. C94, Standard Specification for Ready-Mixed Concrete.
   f. C150, Standard Specification for Portland Cement.
   g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
   h. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   i. C494, Standard Specification for Chemical Admixtures for Concrete.
   j. C618, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
   k. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
3. Concrete Reinforcing Steel Institute (CRSI):
   a. Manual of Standard Practice, 1990, 25th Edition.
   b. Recommended Practice for Placing Reinforcing Bars.

1.2 SUBMITTALS

A. Shop Drawings:

1. Reinforcing steel in accordance with CRSI 1990 Manual of Standard Practice and ACI SP.
2. Curing compound data.
3. Complete data on the concrete mix, including aggregate gradations and admixtures, in accordance with ASTM C94.
4. Grout data.

B. Quality Control Submittals:

1. Manufacturer's application instructions for curing compound.
2. Ready-mix delivery tickets for each truck in accordance with ASTM C94.

1.3 QUALITY ASSURANCE

A. Formwork: Unless otherwise specified, follow the recommendations of ACI 347.

B. Concrete and Reinforcement: Unless otherwise specified, meet the requirements of ACI 301 and 318/318R.

C. Hot Weather Concreting: Conform to ACI 305R.

D. Cold Weather Concreting: Conform to ACI 306R.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Do not place Concrete when the ambient temperature is below 40 degrees F or approaching 40 degrees F and air temperature less than 40 degrees F for the first 7 days, without special protection to keep Concrete above 40 degrees F.

B. Where the use of solvents in the curing compounds are prohibited by state or federal air quality laws, use only water curing methods.

PART 2 PRODUCTS

2.1 CONCRETE

A. Ready-mixed meeting ASTM C94, Option A.

B. Portland Cement: ASTM C150, Type I or Type II.

C. Admixtures:

1. Air-Entraining: ASTM C260.
2. Water-Reducing: ASTM C494, Type A or D.
3. Superplasticizers: ASTM C494, Type F or G.
4. Fly Ash: ASTM C618, Class C or F.

D. Mix Design:

1. Minimum Allowable 28 day Compressive Field Strength: 4,000 psi when cured and tested in accordance with ASTM C31 and C39.
2. Coarse Aggregate Size: 1 inch and smaller.
3. Slump Range: 3 to 5 inches.
4. Air Entrainment: Between 3 and 6 percent by volume.
5. Water Reducers: Use in all concrete.
6. Superplasticizers: Use is optional.

E. Mixing: Minimum 70 and maximum 270 revolutions of mixing drum. Nonagitating equipment is not allowed.

2.2 REINFORCING STEEL

A. Deformed Bars: ASTM A615, Grade 60.

2.3 ANCILLARY MATERIALS

A. Expansion Joint Filler: ASTM D994, 1/2-inch thick, or as shown.

B. Nonshrink Grout:

1. Color: To match concrete.
2. Manufacturers and Products:
   a. Master Builder Co., Cleveland, OH; SET GROUT (Category I).
   b. Master Builder Co., Cleveland, OH; Master Flow 928 (Category II).
   c. Euclid Chemical Co., Cleveland, OH; Hi-flow Grout (Category II).

C. Low Pressure Mortar:

1. Manufacturer and Product: Master Builders Co.; EMACO S88CA with Concresive liquid (LPL) bonding agent.

D. Curing Compound:

1. Material: Solvent based containing chlorinated rubber solids in accordance with ASTM C309, with additional requirement that the

moisture loss not exceed 0.030 gram per centimeter squared per 72 hours.

2. Manufacturers and Products:
   a. Master Builders Co.; Masterkure CR.
   b. Euclid Chemical Co.; Euco Super Floor Coat.

PART 3 EXECUTION

3.1 FORMWORK

A. Form Materials:

1. Use hard plastic finished plywood for exposed areas, and new shiplap or plywood for unexposed areas.
2. Earth cuts may be used for forming footings.

B. Form Ties:

1. Fixed conical or spherical type inserts that remain in contact with forming material and allow for dry packing of form tie holes.
2. Ties shall withstand pressures and limit deflection of forms to acceptable limits.
3. Wire ties are not acceptable.

C. Construction:

1. In accordance with ACI 347.
2. Make joints tight to prevent escape of mortar and to avoid formation of fins.
3. Brace as required to prevent distortion during concrete placement.
4. On exposed surfaces locate form ties in uniform pattern.
5. Construct so ties remain embedded in the wall with no metal within 1-inch of concrete surface when forms, inserts, and tie ends are removed.

D. Form Removal:

1. Wall forms may be stripped after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
   a. Concrete is sufficiently hard so as not to sustain damage by form removal operations, and
   b. Curing and protection operations are maintained.
2. Remove forms with care to prevent scarring and damaging the surface.

3.2 PLACING REINFORCING STEEL

A. Unless otherwise specified, place reinforcing steel in accordance with CRSI Recommended Practice for Placing Reinforcing Bars.

B. Tie splices and laps with 18-gauge annealed wire as specified in CRSI Standard.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 301.

B. Prior to placing concrete, remove water from excavation and debris and foreign material from forms. Check reinforcing steel for proper placement and correct discrepancies.

C. Before depositing new concrete on old concrete, clean surface using sandblast or bushhammer or other mechanical means to obtain a 1/4-inch rough profile, and pour a cement-sand grout to minimum depth of 1/2-inch over the surface. Proportion 1 part cement to 2.5 parts sand by weight.

D. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 2 feet deep. Place within 1-1/2 hours after adding cement to mix.

E. 8 feet maximum vertical drop to final placement, when not guided with chutes or other devices to prevent segregation due to impact with reinforcing.

3.4 COMPACTION

A. Vibrate concrete as follows:

1. Apply approved vibrator at points spaced not farther apart than vibrator's effective radius.
2. Apply close enough to forms to vibrate surface effectively but not damage form surfaces.
3. Vibrate until concrete becomes uniformly plastic.
4. Vibrator must penetrate fresh placed concrete and into previous layer of fresh concrete below.

3.5 CONSTRUCTION JOINTS

A. Locate as shown or as approved.

3.6 FINISHING

A. Floor Slabs and Tops of Walls:

1. Screed surfaces to true level planes.
2. After initial water has been absorbed, float with wood float and trowel with steel trowel to smooth finish free from trowel marks.
3. Do not absorb wet spots with neat cement.

B. Unexposed Slab Surfaces: Screed to true surface, bull float with wood float, and wood trowel to seal surface.

C. Tolerances: Floors shall not vary from level or true plane more than 1/4-inch in 10 feet when measured with a straightedge.

D. Exterior Slabs and Sidewalks:

1. Bull float with wood float, wood trowel, and lightly trowel with steel trowel.
2. Finish with broom to obtain nonskid surface.
3. Finish exposed edges with steel edging tool.
4. Mark walks transversely at 5-foot intervals with jointing tool.

3.7 FINISHING AND PATCHING FORMED SURFACES

A. Cut out honeycombed and defective areas.

B. Cut edges perpendicular to surface at least 1-inch deep. Do not feather edges. Soak area with water for 24 hours.

C. Patch with low pressure mortar as specified.

D. Finish surfaces to match adjacent concrete.

E. Keep patches damp for minimum 7 days or spray with curing compound to minimize shrinking.

F. Fill form tie holes with Category I Nonshrink Grout.

3.8 PROTECTION AND CURING

A. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.

B. Keep concrete slabs continuously wet for a 7 day period. Intermittent wetting is not acceptable.

C. Use curing compound only where approved by COTR/CM and where the use of solvents in the curing compound are not prohibited by state or federal air quality laws. Cure formed surfaces with curing compound applied in accordance with manufacturer's directions as soon as forms are removed and finishing is completed.

D. Remove and replace concrete damaged by freezing.

3.9 FIELD TESTS

A. Evaluation of Concrete Field Strength: In accordance with ACI 318/318R.

3.10 NONSHRINK GROUT

A. Mix, place, and cure nonshrink grout in accordance with grout manufacturer’s instructions.

END OF SECTION

SECTION 03315
PRESTRESSED TANK

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 506R, Guide to Shotcrete.
   b. 506.2, Specification for Shotcrete.
2. American Society for Testing and Materials (ASTM):
   a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   c. A366, Standard Specification for Commercial Steel (CS) Sheet, Carbon, (0.15 Maximum Percent) Cold-Rolled.
   d. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   e. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
3. Federal Specifications: FS TT-P-0035(1), Paint, Cementitious, Powder, White and Colors (for Interior and Exterior Use).
4. International Conference of Building Officials (ICBO): Uniform Building Code (UBC), Section 2333.
5. Prestress Concrete Institute (PCI): Mnl-120, PCI Design Handbook-Precast and Prestressed Concrete.

1.2 DEFINITIONS

A. Prestressed Tank System: Consists of a fine grading foundation as specified in Section **[A: 02316, EXCAVATION,] [B: ,]** an underdrain system as specified in Section **[C: ,]** a cast-in-place concrete floor slab, a core wall, and roof.

B. Shotcrete: Mortar projected jet directly upon intended surface.

1.3 DESIGN REQUIREMENTS

A. Obtain services of a qualified design engineer, as defined in Article QUALITY ASSURANCE, to design Prestressed Tank System conforming to attributes specified in this section.

B. Floor Slab: Cast-in-place concrete, minimum reinforcing in slab equals 0.004 times concrete section.

C. Roof: **[A: Cast-in-place concrete dome with minimum thickness of [B: 3] [C: 5] inches and minimum reinforcing of 0.0025 times concrete section with a minimum area of reinforcing steel each way equal to 0.120-inch squared;] [D: or] [E: cast-in-place concrete flat slab roof with internal concrete columns, and minimum reinforcing of four at 12 inches each way top and bottom of slab.]**

D. Walls: **[A: Cast-in-place concrete core wall with plastic water stops at construction joints;] [B: or] [C: Shotcrete core wall with continuous internal steel diaphragm or precast concrete core wall with steel diaphragm, vertical joint seals, and Shotcrete coverings.]** Walls placed on elastomeric bearing pads, free to move radially, and plastic water stop connection between wall and footing. Satisfy allowable stress requirements when calculating wall thicknesses.

E. Openings and Penetrations: Except for access manholes, other openings or penetrations through wall not permitted. Pipe penetrations shall be through floor slab and under footings. Pipe sleeves are allowed through footing for Shotcrete equipment.

F. Design Loads and Foundation Criteria:

1. Dead Loads: **[A:]** psf.
2. Roof Live Load: **[B: [C:] psf for dome roof.] [D: or] [E: [F:] psf for flat slab roof.]**
3. Wind Load: **[G: 20] [H:]** psf.
4. Winter Temperature: Water **[I:]** degrees F, and outside air **[J:]** degrees F.
5. Summer Temperature: Water **[K:]** degrees F, and outside air **[L:]** degrees F.
6. Differential Drying Allowance: 10 degrees F shall be additive to temperature differential during winter.
7. **[M: Timber Piles: Maximum vertical load of [N: 25] [O:] tons. Establish pile locations; however, do not exceed dimensions for pile spacing as shown.]**
8. Maximum Foundation Bearing Pressure: **[P:]** psf (bearing pressure includes weight of water).
9. Maximum Differential Settlement: **[Q:]** psf.
10. Seismic Zone Forces: Zone **[R:]** in accordance with UBC, Section 2333.

1.4 SUBMITTALS

A. Shop Drawings:

1. Design Data:
   a. Proposed details, concepts, stress calculations, and manhole opening for prestressed tank walls.

b. For design loads and foundation criteria, show calculations and details based on the seismic zone forces.
c. Details of vertical post-tensioning system.
d. Details for sealing vertical joints of steel diaphragm shell.
e. Details of prestressed tank accessories.
f. Calculations stamped by professional engineer.
g. Design drawings stamped by a professional engineer.

2. **[A: Curing methods for dome concrete.]**
3. Description of construction method and materials.

B. Samples: Vertical joint of steel diaphragm shell together with integral pumped epoxy material or other approved method to show evidence of satisfactory seal.

C. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance:
   a. Shotcrete sand.
   b. Concrete and Shotcrete admixtures do not contain chlorides or other corrosive chemicals.
   c. Vertical Post-Tensioning System: Manufacturer's load strain curves certifying physical properties of steel and standard test data that components of anchorage units conform to specified requirements.
2. Manufacturer's Certificate of Proper Installation.
3. Certificates of Inspection: Vertical post-tensioning units have been inspected prior to shipment and contain no apparent defects.
4. Statements of Qualification:
   a. Registered professional engineer.
   b. Prestressed tank installer.
5. Written Test Reports of Each Test and Inspection:
   a. Shotcrete.
   b. Mill test data of chemical composition for vertical post-tensioning system.
   c. Test reports for prestressing steel components.
   d. Mill test data for circumferential prestressing material regardless of manufacture. Include chemical composition, physical properties, and dimensions of steel **[A: prior to galvanizing.]** Mill test data for at least three samples of final prestressing material taken from material delivered to site. Identify each roll that samples were taken from. Identify packages or rolls of prestressing material with mill and heat number.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Qualified Design Engineer: Registered in the state of Project.

2. Prestressed Tank Installer: Company specializing in design and construction of prestressed tanks. Minimum 5 years' experience on tanks of similar size and type required for Project. Company has designed and built no less than five comparable prestressed (wire or strand wrapped) tanks now in use and are giving satisfactory service. Tanks shall have been constructed within the last 5 years. Include name and address of owners.

B. Shotcrete Panel Mockups:

1. When not using automated equipment, assemble test panel at least 30-inch by 30-inch for each mix being considered.
2. Assemble test panels to same thickness as structure, but not less than 3 inches.
3. Take minimum three cubes or cores from panels for strength testing of Shotcrete.
4. Cut or broken surfaces shall be dense and free from laminations and sand pockets.
5. Retain and maintain test panels during construction to establish standards by which completed Shotcrete Work will be judged.
6. Independent Testing Laboratory Services will:
   a. Test proposed materials, including water.
   b. Test proposed mix proportions.
   c. Test specimens.
   d. Secure production samples of materials at plants or stockpiles during construction and test.
   e. Test strength of Shotcrete as Work progresses.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Materials delivered prior to time required, store in a dry, ventilated building, heat if necessary to prevent accumulation of moisture on materials or in wrapping. Do not store on ground or expose to weather.

B. Do not bend vertical post-tensioning bars during handling and storage. Replace bent bars, bars with surface damage, and bars with excessive rusting.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Delay Work under the following conditions:

1. During high winds causing sand to separate at the nozzle.
2. When weather approaches freezing defined as below 40 degrees F when temperature is falling, or until temperature is 35 degrees F when temperature is rising.
3. During rains of high intensity to wash cement out of fresh material.

B. Cold Weather: Take precautions to avoid low temperatures detrimental to epoxy grout or the ability to pump. If grouting procedure cannot be postponed, keep wall temperatures within the required temperature range.

C. Hot Weather: When temperatures exceed 90 degrees F, obtain approval for method used to protect Shotcrete from excessive heat and drying.

D. Do not expose circumferential prestressing on walls to weather for more than 72 hours. Exercise precautions during adverse weather conditions.

PART 2 PRODUCTS

2.1 CONCRETE

A. In accordance with Section **[A: 03300, CAST-IN-PLACE CONCRETE,] [B: ,] [C: except that a 3/8-inch maximum size aggregate may be used for dome concrete if designed for strength and maximum density.]**

B. Minimum Design Strengths:

1. **[A: Dome Roof: 4,000 psi.]**
2. **[B: Flat Roof: 3,000 psi.]**
3. Core Wall: 4,000 psi.
4. Floor Slab: 3,000 psi.

C. Admixtures: As specified in Section **[A: 03300, CAST-IN-PLACE CONCRETE.] [B: .]**

2.2 SHOTCRETE

A. Fine Aggregates (Sand):

1. Saturated, surface dry, hard, dense, uncoated rock fragments free from injurious amounts of foreign or deleterious substances as specified in Section **[A: 03300, CAST-IN-PLACE CONCRETE.] [B: .]**
2. Fineness Modulus for Sand: Range from 2.70 to 3.00 with maximum particle size of 1/4-inch.
3. Maintain sand at 3 to 6 percent moisture content; dampen or dry with sand dryers if necessary.
4. Gradation:

Sieve Size	Percent Passing by Weight
No. 4	97 - 100
No. 8	90 - 98
No. 16	70 - 85
No. 30	35 - 55
No. 50	12 - 25

Sieve Size	Percent Passing by Weight
No. 100	2 - 8

B. Screen sand for finish coat to produce uniform dense surface in texture and appearance.

C. Water and Cement: As specified in Section **[A: 03300, CAST-IN-PLACE CONCRETE.] [B: .]**

D. Admixtures: As specified in Section **[A: 03300, CAST-IN-PLACE CONCRETE.] [B: .]**

E. Minimum design strength 4,000 psi.

2.3 WELDED WIRE FABRIC

A. In accordance with ASTM A82 and ASTM A185.

2.4 MILD STEEL REINFORCING

A. Deformed Grade 40 bars with maximum service load design, allowable stress of 18,000 psi in accordance with ASTM A615.

2.5 CIRCUMFERENTIAL PRESTRESSING STEEL

A. High Tensile **[A: Hot-Dipped Galvanized]** Wire:

1. Diameter tolerance of wire plus or minus 0.002-inch.
2. **[B: Diameter tolerance after galvanizing 0.001-inch]**
3. Tensile strength minimum 210,000 psi.
4. Yield strength at 1 percent extension minimum 170,000 psi.
5. Elongation in 10 inches at fracture minimum 4 percent.
6. Bending (R equals 5D), minimum 6 bends per 90 degrees.
7. **[C: Weight of zinc coating minimum 0.85 oz/sq ft.]**

B. Hot-Dipped Galvanized Seven-Wire Continuous Strand:

1. Strand diameter tolerance plus or minus 1/32-inch.
2. Pitch 12-16 (strand diameter).
3. Tensile strength minimum 240,000 psi.
4. Yield strength at 1 percent extension minimum 180,000 psi.
5. Elongation in 24-inch fracture minimum 4.5 percent.
6. Weight of zinc coating minimum 0.75 oz/sq ft.

C. Anchorage: Prestressing manufacturer's standard and capable of safely developing full strength of units, and not susceptible to galvanic action with prestressed steel.

D. Prestressing Steel Requirements:

1. Initial prestress force in circumferential prestressing units after anchoring shall not exceed 70 percent of guaranteed ultimate strength. Coordinate value with tolerance requirements and reflect values in calculations.
2. Final prestress force in circumferential prestressing units, when using nonelectronic or electronic wrapping machine, not capable of close stress tolerance, shall be determined by using stress loss of 25,000 psi for concrete shrinkage, plastic flow, and creep in steel plus 6 percent of initial wire stress system tolerances.
3. Calculate final circumferential prestress force and location on wall. Final prestress force shall provide for minimum residual compression in wall, above that required to resist internal water pressure of 100 psi. Maximum compression in core wall limited to 0.45 times design strength of core wall when using final prestress force after all losses. Maximum initial compression in core wall limited to 0.55 times design strength of core wall. Calculate wall thickness to comply with these requirements and bending requirements.

2.6 VERTICAL TENDONS

A. Solid High Strength Alloy Steel Bar:

1. Minimum ultimate tensile strength 145,000 psi.
2. Minimum yield stress at 0.2 percent offset 125,000 psi.
3. Approximate modulus of elasticity 30,000,000 psi.
4. Minus elongation in 20 diameters after rupture 4 percent.
5. Minimum reduction of area after rupture 20 percent.

B. Tendon Ducts:

1. Rigid **[A: galvanized metallic sheath or tubing.] [B: or] [C: PVC pipe.]**
2. Sufficient strength to maintain its shape under potential forces created during handling, placing, and vibrating of concrete.
3. Inside diameter of grout and vent pipe 3/8-inch larger than diameter of vertical tendon.

C. Anchorage:

1. Furnish anchor plates of steel to dimensions which will show no permanent physical distortion when tested with a unit of size required, together with standard anchorage devices, and to 100 percent of ultimate tensile strength of unit.
2. Size plate so concrete stresses shall meet allowable concrete bearing stresses in accordance with PCI Mnl-120.

2.7 STEEL DIAPHRAGM SHELL

A. Tank diaphragm in accordance with ASTM A366 for Commercial Quality cold-rolled steel sheet. Minimum of 26 gauge sheet and form corrugations of a pattern to form a continuous positive watertight seal and a strong mechanical key between Shotcrete and steel. Furnish steel sheets in one continuous length to full height of wall. Vertical joints between sheets.

2.8 SHOTCRETE MIX PROPORTIONS

A. Adjacent to Steel Diaphragm and Over Wires: 1 part cement to 3 parts sand.

B. All Other: 1 part cement to 4 parts sand.

PART 3 EXECUTION

3.1 GENERAL

A. Foundation:

1. Encase tank piping under foundations in concrete.
2. Support floor slab with timber piles as specified in Section 02461, TREATED TIMBER PILES.

B. Welded Wire Fabric: Adequately support prior to placement of concrete.

3.2 CORE WALL

A. Do not begin prestressing until core wall has obtained a compressive field strength of 4,000 psi or higher as determined by tests. **[A: Exterior surface of core wall, if of cast-in-place or precast concrete, sandblasted prior to application of prestressing wire.]**

B. Sandblasting Core Wall:

1. Sandblast exterior surfaces of core wall after inspecting patches for corrosive chemicals, to remove traces of original surface smoothness and original surface color, form oil, and laitance.
2. Complete sandblasting prior to installation of circumferential prestressing.
3. Use dry type method of sandblasting with No. 16 silica sand.
4. Sandblast far enough in advance of prestressing operation not to interfere with other operations.
5. Leave wall clean, heavily pitted, and uniform in appearance.
6. Sandblasting operation shall not prevent satisfactory curing of wall.

3.3 CIRCUMFERENTIAL PRESTRESSING

A. Apply uniformed stressed steel wire **[A: or strand]** to core wall using a wrapping machine to provide the final prestressing force per linear foot of wall height. Electronic servo controlled wrapping systems with automatic

electronic recording may be used. Nonelectronic wrapping machines may also be used.

B. Stress Measurement and Recording:

1. Apparatus capable of measuring stress of circumferential prestressing units accurately.
2. Gauges or other stress measuring apparatus calibrated by a recognized gauge manufacturer or testing laboratory on wire **[A: or strand]** samples taken from prestressing steel delivered to site to be used in the Work.
3. Perform calibration work performed within 15 days prior to prestressing.
4. Recalibrate stress measuring apparatus during progress of Work.
5. If stresses measured exceed values specified, discontinue operation and make satisfactory adjustments prior to proceeding with wrapping.
6. Apply additional wire **[B: or strand]** to compensate for understressed wire **[C: or strand.]**
7. Base measurements of wire **[D: or strand]** stress on a continuous sensing of applied force on wire between tensioning drum and wall when, and as, wire is being wrapped and laid on wall.

C. Splicing of Wire **[A: or Strand:]**

1. Do not weld splice wire **[B: or strand,]** except when terminating one complete coil or in event of a defect.
2. Join ends of wire **[C: or strand]** with steel sleeves or splicing devices which will develop full strength of wire **[D: or strand]** without slippage or loss of stress.
3. Anchor stressed prestressing steel, or tie off at frequent intervals as stressing proceeds to minimize loss of stress in event of breakage.
4. Remove from Work, coils of prestressing steel which have broken three or more times.
5. Stress prestressing steel only once.
6. Anchor wrapped prestressing steel to wall at least once for every coil or reel.
7. Do not permanently anchor one wire **[E: or strand]** to previously wrapped wire.

D. Spacing:

1. Space at minimum five wires of 0.162 to 0.192-inch in diameter, **[A: or four strands of 0.375-inch in diameter,]** per foot of wall height, and maximum 22 wires **[B: or 12 strands]** per foot.
2. Minimum clear spacing between units not less than 1.5 unit diameters or 3/8-inch, whichever is larger.
3. Spread or remove from Work prestressing steel wrapped closer together.
4. Space wire **[C: or strand]** of other diameters.

3.4 SHOTCRETING OF CIRCUMFERENTIAL PRESTRESSING STEEL

A. In accordance with ACI 506.2 and ACI 506R. Application of dry or wet mix is acceptable.

B. Cover each layer and outer layer of prestressing steel with a coating of Shotcrete. Work from bottom to top of wall.

C. Completely embed the prestressing steel without voids. Maintain uniform flow of material from nozzle.

D. Cut out slugs, sand spots, or wet sloughs resulting from nonuniform material flow and repair as Work progresses.

E. Clear rebound away from Work before initial set occurs.

F. Time the intervals between successive applications to allow for initial set to develop. After initial set, stiff broom Shotcrete layers receiving another coat to remove laitance and to provide a bond with succeeding applications.

G. Adjust amount of water in Shotcrete placed on vertical surfaces. Thickness of Shotcrete approximately 3/4-inch.

H. Remove deposits of loose sand before placing succeeding layers of Shotcrete. Clear rebound away continuously from the Work, and do not reuse rebounded sand.

I. Slope construction joints or day's work joints off to thin, clean, and to regular feathered slope edge. Thoroughly clean sloped portion and adjacent Shotcrete with mortar film coating. Wet and scour with air jet, or sandblast with silica sand before placing adjoining Work.

J. Where more than one layer of circumferential prestressing units are required, maintain minimum 1/4-inch cover over each underlayer. Shotcrete cover over outer layer shall be a minimum of 1-inch thickness applied in a minimum of three coats. Provide 1/4-inch minimum cover over prestressing unit for first coat. Apply finish coat approximately 1/4-inch thickness. Layers of Shotcrete shall be broomed after initial set except finish coat.

3.5 VERTICAL POST-TENSIONING

A. Install post-tensioning units level and plumb in tank wall, tie units securely in position.

B. Tendon Ducts:

1. Encase vertical post-tensioning units in rigid grout-tight tendon ducts to prevent mortar from entering and hindering free movement of bars.

2. Maintain shape of ducts during handling, placing, and vibrating of concrete.
3. Attach by threads, vent pipe to tubing for venting and grouting.
4. Thread end of grout tube at bottom and project from concrete.
5. Thread bottom of vent pipe at both ends, attach pipe securely during construction and remove after grouting.

C. Connections shall be tight between anchors, tubing or pipe, and forms to prevent movement or leakage of grout into units during pouring operations. Provide threaded hose connections to threaded vent pipe and connections shall be tight to keep water from entering forms below.

D. Tension units from top ends.

E. Flush the tendon ducts with water through top vent pipe several times during wall pour allowing water to drain from bottom grout pipe, extending through wall form.

F. After completion of pour and flushing operation, give pipes a short burst of air at top pipe to clear out accumulated water at bottom of tendon duct. Do not clean tendon ducts with air or water connected to bottom grout pipe.

G. Allowable Stresses:

1. Determine initial post-tensioning force for vertical bar units by using a 25,000 psi stress loss allowance for concrete shrinkage, plastic flow, and steel relaxation.
2. Temporary jacking stresses up to 80 percent of ultimate strength for unit are acceptable to overcome losses due to tendon friction, anchorage seating, and elastic shortening.
3. Initial stress in bar unit after anchorage losses have occurred shall not exceed 70 percent of ultimate strength of unit.
4. Do not stress units before the 28 day concrete field strength has been obtained.

H. After tensioning units, flush tendon ducts out with water and blow out with air. Provide machine capable of 150 psi to clear obstructions in tendon ducts. Fill tendon ducts with grout under pressure of approximately 80 psi.

3.6 GROUTING VERTICAL TENDONS

A. Provide neat cement for grouting vertical post-tensioning units after stressing. Mix neat cement and screen through fine screen. Provide enough water to obtain a creamy consistency to ensure cement and water do not separate in tendon ducts.

B. Introduce grout through bottom grout pipe until it flows from a 3 foot extension attached to upper end of tendon ducts. Valve off bottom grout pipe no earlier than the day following grouting operation and remove bottom tube.

Secure tendon duct tight enough to allow grout to enter the extension pipe without leakage in vicinity of top baseplate.

3.7 FINISHING OF SHOTCRETE

A. Underlayers or Exposed Surfaces:

1. On completing surfaces, bring Shotcrete to an even plane and to well-formed corners by working up to ground wires or other thickness or alignment guides, using lower placing velocity than normal.
2. Screed exposed surfaces or underlayers by working upward against gravity with thin-edged screed using a slicing motion to trim off high spots and expose low spots.
3. Avoid pulling and breaking surface with subsequent checking.

B. Finish Coat:

1. Apply coat to remove rough areas after ground wires have been removed.
2. Carefully screen sand for finish coat to remove oversize particles which rebound and mar surfaces.
3. Surface of finish coat shall be; of natural texture and coloration; free from spotting, cement or dust streaking, lap lines, uneven surfaces, and rebounded material.
4. Do not hand-patch.
5. Check coatings for bond by tapping lightly to test for hollow sounding spots.
6. Cut out areas where bond is not fully developed and repair.

C. Corrosion Protection:

1. Inspect core wall and patched surfaces.
2. Test surfaces for chlorides or other chemicals that cause corrosion of prestressing.
3. Remove corrosive chemicals from surfaces prior to sandblasting.
4. Patch surfaces by building out in uniform circular area level with surface.
5. Sandblast patches and core wall surfaces prior to application of prestressing and Shotcrete.

3.8 CURING

A. **[A: Dome Concrete:**

1. Water cure dome concrete for 7 days by keeping surface continuously wet.
2. Schedule wire wrapping and application of Shotcrete so curing shall not be interrupted, and water from curing shall not wash or damage Shotcrete wire coats.

3. **Begin curing after initial concrete set has occurred.]**

B. Shotcrete:

1. Keep Shotcrete between layers of wire and cover damp by hand watering or fine mist spray.
2. Continuously water cure completed Shotcrete surfaces for period of 7 days after application, or until subsequent Shotcrete coats are applied prior to end of the 7 day curing period.
3. Remove laitance from wall by light sandblasting after curing period.
4. Do not use curing compounds.

3.9 PAINTING

A. Paint exterior surface of tank as specified in Section **[A: 09900, PAINTING [B: AND PROTECTIVE COATINGS].] [C: .]**

3.10 TESTS

A. Shotcrete Panel Field Tests:

1. When length of core is less than twice diameter, apply correction factors in accordance with ASTM C42 to obtain compressive strength of individual cores.
2. Average compressive strength of three cores taken from test panel equal or exceed 0.85 f'c with no individual core less than 0.75 f'c. Average of three cubes taken from a panel equal or exceed f'c with no individual cube less than 0.88 f'c.
3. Shotcrete will be based on results obtained from cores or sawed cubes.
4. Use of data obtained from impact hammers, ultrasonic equipment, or nondestructive testing devices is not permitted. However, these devices may be used for determining uniformity of Shotcrete.
5. Remove and replace Shotcrete found not meeting tests, or cut cores and further test Shotcrete, or repair and replace as approved by ENGINEER.

B. Water test tank as specified in Section **[A: 03300, CAST-IN-PLACE CONCRETE.] [B: .]**

3.11 DISINFECTION

A. In accordance with Section 02519, DISINFECTION OF WATER SYSTEMS.

END OF SECTION

SECTION 04230
REINFORCED UNIT MASONRY

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. C33, Standard Specification for Concrete Aggregates.
   d. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   e. C140, Standard Methods of Sampling and Testing Concrete Masonry Units.
   f. C144, Standard Specification for Aggregate for Masonry Mortar.
   g. C150, Standard Specification for Portland Cement.
   h. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   i. C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
   j. C270, Standard Specification for Mortar for Unit Masonry.
   k. C404, Standard Specification for Aggregates for Masonry Grout.
   l. C476, Standard Specification for Grout for Masonry.
   m. C652, Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale).
2. Brick Institute of America (BIA).
3. International Conference of Building Officials (ICBO):
   a. UBC Structural Engineering Design Provisions, Volume 2, Chapter 17 and Chapter 21.
   b. UBC Standard 21-16, Field Test Specimens for Mortar.
   c. UBC Standard 21-18, Method of Sampling and Testing Grout (ASTM C1019).
4. National Concrete Masonry Association (NCMA).

1.2 SUBMITTALS

A. Shop Drawings:

1. Information illustrating horizontal joint reinforcement and preformed control joint materials proposed.

2. Grout proportions.
3. Mortar proportions.
4. Letter of certification stating grout aggregates and mortar sand meet nonreactivity requirements of ASTM C33.

B. Samples:

1. Individual Sample of each type of masonry unit to be used on Project.
2. Two each, Samples of textured, glazed, sound absorbing, and brick units for selection of color and texture.

C. Quality Control Submittals:

1. Method of placing grout.
2. Certified field test results within 5 days of performing specified tests.

1.3 QUALITY ASSURANCE

A. Mockups:

1. Lay up Sample panel for each type of masonry at the site.
2. Dimensions: Minimum 4 feet high by 4 feet long.
3. May be part of permanent construction.
4. Approved panels shall serve as basis of color, texture, bond, quality of finished joints, and for acceptance of permanent construction.
5. Demonstrate ability to keep grout isolated and in certain cells during any sequence of placement, and to demonstrate materials will be restricted to cells and bond beams intended to receive each material.
6. Construction shall show areas required to receive mortar.
7. Where bond beams are to be used, demonstrate proper placement of grout to bond beam level, and proper placement of bond beam prior to placement grout above bond beam level.
8. Demonstrate proper use of running bond or stacked bond.

B. Efflorescence: Protect masonry construction to prevent efflorescence. Provide measures to prevent moisture from entering incomplete walls. Remove all efflorescence prior to applying water repellents.

C. Comply with the requirements and criteria of the National Concrete Masonry Association (NCMA), Brick Institute of America (BIA), ASTM C90, ASTM C216, and ACI 530.1 for masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Keep lime and other ingredients dry.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when ambient temperature is below 32 degrees F on a rising temperature, or below 40 degrees F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless written approval of procedures for protection from freezing is obtained from COTR/CM.

B. Moisture Protection: Protect masonry construction from loss of moisture during curing period of 7 days when ambient air temperature is 90 degrees F or greater and when relative humidity is less than 50 percent.

PART 2 PRODUCTS

2.1 COMPRESSIVE STRENGTH OF MASONRY

A. Minimum 28-Day Compressive Field Strength, f'm, of the Completed Assemblage: 1,500 psi.

2.2 MASONRY UNITS

A. General:

1. Furnish or cut special shapes for corners, jambs, lintels, and other areas shown or required.
2. Special units shall match color and texture of standard units.
3. Where units are placed so end of unit is exposed, such as at a corner or intersection, the exposed end of that block shall have surface to match color and texture of sides of other units.
4. Furnish sound, dry, clean units free of cracks, prior to placing in structure.
5. Vertical Cells to be Grouted: Capable of alignment sufficient to maintain clear, unobstructed continuous vertical cell in accordance with UBC Table 21-C.
6. Masonry unit size and shape shall allow for all placement patterns to prevent materials, such as grout, from escaping from cell being filled to adjacent cells where material is not intended to be placed.

B. Concrete Masonry Units (CMU):

1. ASTM C90, Type I for humid humidity conditions of use; normal weight.

2. Nominal Size: 16 inches long by 8 inches high by thickness shown on Drawings.
3. Compressive Strength: 1,900 psi minimum, in accordance with ASTM C90, Table 3.
4. Color of Units: Natural.
5. Surface Texture on Exposed Surfaces: Smooth.
6. Surface Texture: Smooth on interior, concealed exterior, and surfaces 1 foot below finished grade.

2.3 MORTAR AND GROUT MATERIALS

A. Cement: ASTM C150, Type I, or Type II, portland cement.

B. Lime: ASTM C207, Type S hydrated.

C. Aggregates:

1. Mortar: ASTM C144, sand.
2. Grout: ASTM C404.

D. Water: Fresh, clean, and potable.

E. Mortar Plasticizer Admixture: May be used instead of lime.

1. Manufacturer and Product: American Colloid Co.; Easy/Spred Plasticizer.

F. Grout Admixture: Controlled expansion additive.

1. Manufacturer: Sika Corporation, Lyndhurst, NJ; Grout Aid.

2.4 REINFORCEMENT

A. Horizontal Joint Reinforcement:

1. Two parallel, ASTM A82, No. 9 wires, galvanized in accordance with ASTM A153/A153M,weld connected to No. 9 perpendicular cross wire at 15 inches on center.
2. Reinforcement: Clean and free from loose rust, scale, and coatings that reduce bond.
3. Furnish special manufactured corner and wall intersection pieces.
4. Manufacturer:
   a. Dur-O-Wal, Inc., Aurora, IL.
   b. Hohmann and Barnard, Inc., Hauppauge, NY.
   c. Wirebond, Charlotte, NC.

B. Deformed Bars: As specified in Section 03301 REINFORCED CONCRETE.

2.5 PREFORMED CONTROL JOINTS

A. Solid rubber cross-shape extrusions as manufactured by:

1. Dur-O-Wal, Inc., Aurora, IL; Regular Rapid Control Joint.
2. Sonneborn-Contech Co., Oakland, CA; Sonneborn Control Joint.
3. Hohmann and Barnard, Inc; #RS-Standard.

2.6 MORTAR MIXES

A. Minimum average mortar 28-day compressive strength1,800 psi.

B. Proportions:

1. In accordance with ASTM C270, Type S.
2. Mortar plasticizer admixture may be substituted for lime. Batch in accordance with ICBO, BOCA, or Standard Building Code Current Reports for the specified mortar type and strength.

C. Mixing:

1. Machine mix in approved mixers.
2. Keep mixer drums clean and free of debris and dried mortar.
3. Mix by placing 1/2 water and 1/2 aggregate in operating mixer.
4. Add cement.
5. Add remaining aggregate and water and mix for at least 2 minutes.
6. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after addition of lime.
7. Time addition of admixture in accordance with manufacturer's instructions. Procedure used for adding it to mix shall provide good dispersion.
8. Follow manufacturer's instructions for mortar plasticizer admixture.

2.7 GROUT MIXES

A. Proportions: Conform to ASTM C476 for coarse grout and as follows:

1. Compressive Strength: Minimum 2,000 psi at 28 days.
2. For Pouring:
   a. Fluid consistency (suitable for pouring without segregation) meeting requirements of ASTM C476.
   b. Conform to Uniform Building Code, Tables No. 21-B and 21-C, except as noted.

3. For Pumping: Fluid consistency with minimum seven sacks of cement in each cubic yard.

B. Mixing:

1. Onsite: Follow procedure specified in Article MORTAR PRODUCTION.
2. Transit-Mixed Grout: Meet requirements of ASTM C476.
3. Add approved grout expansion admixture in accordance with manufacturer's recommendations. Premix admixture with water and add resulting solution to grout mix and thoroughly mix. Do not exceed quantity of admixture recommended by manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare surface contact area of foundation concrete for initial mortar placement by one of following methods:

1. Sandblasting foundation and reinforcing dowels after concrete has fully cured to remove laitance and spillage and to expose sound aggregate.
2. Water blasting foundation and reinforcing dowels after concrete has partially cured to remove laitance and spillage and to expose sound aggregate.
3. Green cutting fresh concrete with high pressure water and hand tools to remove laitance and spillage from foundation and reinforcing dowels and to expose sound aggregate.

B. Clean surfaces of loose material prior to initial mortar placement.

C. Prevent surface damage to foundation concrete that will be exposed to view outside of contact area.

3.2 LAYING MASONRY UNITS

A. General:

1. Conform to Building Code applicable to this Project as supplemented by these Specifications.
2. Do not start laying masonry units unless foundation wall is plumb within 1/4 inch in 10 feet or not straight within 5/16 inch in 10 feet.
3. Finish Tolerances (Measured on Interior Surfaces):
   a. Maximum Permissible Variation From Plumb of Masonry Wall or of Line of Joints in Masonry Wall: 1/16 inch per foot of height, and 1/4 inch in the total height of the wall.

b. Maximum Permissible Variation From Horizontal Line Along Base of Wall or for Lines of Horizontal Joints: 1/16 inch per block, 1/4 inch per 50 feet of wall with proportionately greater tolerance for longer walls up to 1/2 inch in total length of wall.

4. Place units with chipped edges or corners such that chipped area is not exposed to view.

B. Wall Units:

1. General:
   a. If necessary to move a unit after once set in place, remove from wall, clean, and set in fresh mortar.
   b. Toothing of masonry units is not permitted.
2. Running Bond:
   a. Unless otherwise shown, lay up walls in straight, level, uniform courses using a running bond pattern.
   b. Place units for continuous vertical cells and mortar joints to prevent materials such as grout or poured insulation from escaping from cell being filled to adjacent cells where material is not intended to be placed.
3. Corners: Lay standard masonry bond for overlapping units and grout solid.
4. Intersecting Walls: Bond with reinforcement, not with masonry bond.

C. Special Shapes:

1. Provide and place such special units as corner block, door jamb block, lintel block fillers, and similar blocks as may be required.
2. Use required shapes and sizes to work to corners and openings, maintaining proper bond throughout wall.

3.3 BUILT-IN ITEMS

A. Position door frames, windows, vents, louvers, and other items to be built in the wall, and construct wall around them.

B. Install masonry anchors to secure items to wall.

C. Fill spaces around items with mortar or grout.

D. Do not place electrical, instrumentation, or water conduits in a cell containing reinforcement unless approved in writing by COTR/CM. Pipes, sleeves, and conduits shall not be placed closer than three diameters, center-to-center, nor shall they impair the strength of construction.

3.4 MORTAR JOINTS

A. General:

1. Straight, clean, with uniform thickness of 3/8 inch.
2. Horizontal and vertical mortar joints shall have full mortar coverage on face shells.
3. Vertical Head Joints:
   a. Butter well on each unit for a width equal to face shell of unit, shove tightly so mortar bonds well to both units.
   b. Solidly fill joints from face of block to at least the depth of face shell.
4. As units are laid, remove excess mortar from grout space of cells to be filled.
5. Place mortar before initial setting of cement takes place. Do not retemper mortar that has started to set or is not used within one hour. Retempering of colored mortar is not allowed.

B. Exposed Joints:

1. Tool joints exposed to view after final construction, unless otherwise noted or shown.
2. Cut joints flush and, as mortar takes its initial set, tool to provide a concave joint.
3. Perform tooling when mortar is partially set but still sufficiently plastic to bond.
4. Perform tooling with a tool which compacts mortar, pressing excess mortar out rather than dragging it out.
5. Rake out joints which are not tight at time of tooling, point, and then tool.
6. Rake and tool joints at split-face surfaces, interior and exterior.

C. Concealed Joints: Strike flush with no further treatment required.

3.5 CONTROL JOINTS

A. Preformed Control Joints:

1. Omit mortar from vertical joints.
2. Place rubber control joint material as wall is built.
3. After wall is grouted, cured, and cleaned, install backing rod and sealant as specified in Section 07900, JOINT SEALANTS.
4. Place and tool sealant to match depth of typical joint.

3.6 REINFORCING

A. Foundation Dowels:

1. Size, number, and location of foundation dowels shall match vertical wall reinforcing, unless otherwise noted.
2. When foundation dowel does not line up as intended, with vertical core, do not slope more than 1 horizontal to 6 vertical to bring it into alignment.

B. Vertical Reinforcing:

1. Use deformed bars.
2. Hold in position near the ends of bars by wire ties to dowels or by reinforcing positioners.
3. Lap reinforcing bars with foundation dowels 48 bar diameters minimum, 72 bar diameters at all other locations. Wire tie lapped bars together.
4. Minimum Bar Clearance: 1 bar diameter from masonry and from additional parallel bars in same grout space.
5. Hold in position at maximum intervals of 160 bar diameters by reinforcing positioners.

C. Horizontal Reinforcing:

1. Use deformed bars.
2. Lay on webs of bond beam units and place as wall is built.
3. Lap reinforcing bars 48 bar diameters minimum, where spliced and wire tie together.
4. Minimum Bar Clearance: 15 inches from masonry shell and 1 bar diameter from additional parallel bars in same grout space.
5. Terminate reinforcing bars 2 inches clear from control joints as shown.

D. Horizontal Joint Reinforcement:

1. Provide in addition to typical wall reinforcing steel.
2. Space maximum 16 inches apart, vertically.
3. Lap ends 6 inches minimum.
4. At control joints make reinforcement discontinuous.
5. Use manufactured corner and other wall intersection pieces.

3.7 MORTAR PRODUCTION

A. General:

1. Mix ingredients 3 to 5 minutes after all ingredients are introduced.

2. Provide volumetric control by using batching box or similar measuring device. Do not use shovel to introduce materials directly into batch.
3. Keep sand damp and loose.
4. Use cool mix water.

3.8 GROUTING

A. General:

1. Do not mix, convey, or place with equipment constructed of aluminum.
2. Secure vertical and horizontal reinforcement, ties, bolts, anchors, and other required embedments in place, inspect and verify before placing grout.
3. Grout beams over openings in one continuous operation.
4. Maintain vertical alignment in accordance with UBC Table 21-C.
5. Place grout as soon as possible after mortar has set to reduce shrinkage cracking of vertical joints.
6. Vertical Reinforcement:
   a. First wire tie to foundation dowels, then build wall around it.
   b. Provide reinforcing positioners or approved cross-bracing to secure top of steel in place.
   c. Do not drop in vertical steel after block is laid, unless reinforcing positioners are provided in the course above previously grouted course.

B. Grouting Requirements:

1. Slump: 8 to 11 inches
2. Grouting shall not be started until the wall has cured for a minimum of 24 hours.
3. Solid Grouting Requirements: Solid grout all walls as indicated on plans.
4. Partial Grouting Requirements:
   a. Walls Not Requiring Solid Grouting: Fill cells containing reinforcing steel, anchor bolts, and other embedded items as shown with grout.
   b. Construct cells to be filled to confine grout within cell.
   c. Cover tops of unfilled vertical cells under a bond beam with metal lath to confine grout fill to bond beam section.
5. Form horizontal construction joints between pours by stopping grout pour 1-1/2 inches below a mortar joint except at a bond beam, stop pour 1/2 inch below top of masonry unit.
6. Fully embed horizontal steel with grout in an uninterrupted pour.
7. Do not construct wall more than one course above top of grout pour prior to placing grout.

8. Vibration:
   a. Use internal “pencil” type, low energy vibrator to thoroughly consolidate grout and reduce amount of air voids. Do not use concrete vibrators.
   b. After waiting sufficient time to permit the grout to become plastic, but before it has taken any set, reconsolidate grout.
   c. Waiting period will vary depending upon weather conditions and block absorption rates, but under “normal” weather conditions with average masonry units the waiting period should be between 30 to 60 minutes.
9. Cleanouts:
   a. Provide for grout pours over 5 feet in height.
   b. Provide of sufficient size to permit cleaning of cell, positioning of reinforcing, and inspection at bottom of every vertical cell containing reinforcing.
   c. Location: Concealed from view after final construction, unless otherwise approved by COTR/C M.
   d. After wall has been inspected and approved and prior to grouting, cap cleanouts in a manner that will seal them from grout leakage and provide a flush finish.

3.9 FIELD QUALITY CONTROL

A. General: Special Inspection of masonry in accordance with UBC Section 1701.5.7 is required.

B. Provide adequate facilities for safe storage and proper curing of, mortar samples, and grout samples, as applicable, onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

C. Unit Strength Method:
   1. Method and frequency for mortar, grout, and masonry unit sampling and testing in accordance with UBC Section 2105.3.4. Sample and test units in accordance with ASTM C140.
   2. Provide masonry units for test samples required.

D. Corrective Action:

   1. If compressive strength tests made prior to construction of permanent structure fail to meet Specifications, adjustments shall be made to mix designs for the mortar, or grout, or both, as needed to produce specified strength. Masonry units shall also be tested to verify compliance to requirements of ASTM C90, Type 1.
   2. If strength tests performed on materials representative of in-place construction fail to meet Specifications, prisms or cores shall be cut from constructed walls in sufficient locations to adequately determine the strength in accordance with UBC Section 2105.3.5.

3.10 CLEANING

A. Immediately after completion of grouting, clean masonry surfaces, using clean water and fiber brushes, of excess mortar, grout spillage, scum, stains, dirt, and other foreign substances.

B. Clean walls not requiring painting or sealing such that there are no visible stains.

3.11 PROTECTION OF INSTALLED WORK

A. Do not allow grout and mortar stains to dry on face of exposed masonry.

B. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain or snow is imminent and when Work is discontinued.

C. Adequately brace walls until walls and roof are completed.

D. Provide sufficient bracing to protect walls against damage from elements, including wind and snow.

E. Protect masonry against freezing for minimum 72 hours after being laid.

F. Protect masonry from damage until final acceptance of Work. Damaged units will not be accepted.

END OF SECTION

SECTION 04813
MASONRY VENEER

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. C144, Standard Specification for Aggregate for Masonry Mortar.
   b. C150, Standard Specification for Portland Cement.
   c. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   d. C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
   e. C270, Standard Specification for Mortar for Unit Masonry.

1.2 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's product information.
2. Mix designs for mortar.
3. Details for cast stone units and special brickshapes and assemblies.

B. Samples:

1. Full-size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction.
   a. Include size variation data verifying that actual range of sizes for brick falls within ASTM C216 dimension tolerances for brick where modular dimensioning is indicated.
2. Colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.
3. Stone trim samples not less than 12 inches in length showing full range of colors and textures expected in finished construction.
4. Accessories embedded in the masonry.

C. Quality Control Submittals:

1. Experience record of mortar color pigment proposed for use.
2. Manufacturer's certificate of compliance for the masonry units specified herein.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: For masonry construction meet requirements of the Uniform Building Code and as supplemented by these Specifications.

B. Mockups: Lay up a sample panel for each type of masonry at the site to show the bond pattern and method of finishing joints. Make sample panels 4 feet high and 4 feet long and may be a part of the permanent construction. The acceptable sample panel serves as a basis of color, texture, pattern, and workmanship for acceptance of the permanent construction.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:

1. Store all masonry materials off ground and protected from precipitation.
2. Protect veneer materials from mud splatters and staining.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when the ambient temperature is below 32 degrees F on a rising temperature or below 40 degrees F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless express approval of the COTR/CM is obtained. In such case, make special provisions for heating materials and protecting the finished Work. Protect masonry against freezing for a minimum of 48 hours after being laid. Protect the tops of walls from precipitation at all times. Cover with waterproof paper when rain or snow is imminent and Work is discontinued.

B. Humidity: Protect masonry construction from direct exposure to wind and sun when erected in an ambient air temperature of 99 degrees F (37 degrees C) in the shade with relative humidity less than 50 percent.

PART 2 PRODUCTS

2.1 MASONRY UNITS

A. Color, Texture, and Pattern: Match the existing Scott AFB buildings.

B. Facing Brick:

1. General: ASTM C2l6, Grade SW, Type FBX. Minimum compressive strength for individual brick: 3,000 psi; size: 3-5/8 by 2-1/4 by 7-5/8.
2. Manufacturer and Product: Richards Brick Company, Edwardsville, IL; Scott Blend No. 7B-88C.

2.2 CAST STONE

A. Homogeneous, manufactured from portland cement concrete, precast, and of the same composition throughout each piece. The use of selected aggregates for the faces only is expressly prohibited.

B. Sound and perfect, with sharp and true corners.

C. Furnish with holes, reglets, rebates, and other features as required by the design and for installation.

D. Aggregate: Known durability; proportioned to produce maximum density.

E. Properties:

1. Minimum Compressive Strength: 7,000 PSI.
2. Maximum Average Water Absorption: 5 percent.

F. Reinforcing: By manufacturer as required for strength of unit.

G. Properly cure prior to delivery.

H. Manufacturer: Swansea Building Products Corp.

I. Color: 99 White.

J. Texture: Fine, smooth finish similar to cut limestone.

2.3 MORTAR MATERIALS

A. Portland Cement: ASTM C150, Type I, low alkali content (0.60 percent maximum).

B. Lime: ASTM C207, Type S.

C. Mortar: ASTM C270, Type S. Consisting of 1 part portland cement, from 1/4 to 1/2 part lime putty or hydrated lime, and clean well-graded sand in the proportion of three times the sum of the cementitious material; or 1/2 part portland cement, 1 part masonry cement, and clean well-graded sand in the proportion of three times the sum of the cementitious material.

1. If color is added, add in a consistent manner to provide final uniformity.
2. No antifreeze liquid, salts, or other substances are allowed to lower the freezing point. No calcium chloride is allowed in the mortar.

D. Tuck-Pointing Mortar: Prehydrated Type N, 1 part portland cement, 1 part Type S hydrated lime, and 6 parts sand, by volume.

E. Sand: ASTM C144, in addition not less than 5 percent passes the No. 100 sieve.

F. Water: Fresh, clean, and free of deleterious acids, alkalies, chlorides, and organic materials.

2.4 THROUGH-WALL FLASHING

A. Stainless Steel: ASTM A167, Type 302 or 304, No. 20, dull finish, 0.018-inch thick.

B. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual; Figure 4-1.

C. Fabricate corners in one-piece with legs extending 30 inches each way to field joint.

D. Provide end and edge formed dams to control drainage direction.

2.5 MASONRY ACCESSORIES AND ANCILLARY MATERIALS

A. Manufacturers, unless noted otherwise:

1. Dur-O-Wal, Inc.
2. Hohmann and Barnard, Inc.
3. Heckmann Building Products.

B. Brick Ties:

1. Two-piece adjustable ties with wire embedded at least 2 inches into brick wythe.
2. Hot-dip galvanized ties per ASTM A153, Class B-3.
3. Ties should not have mechanical play in excess of 0.05 inch and should not deform over 0.05 inch for 100-lb. load in either tension or compression.

C. Cast Stone Anchors: Where dovetail anchors are not applicable, use galvanized stone anchors unless otherwise shown, and size as shown.

D. Horizontal Joint Reinforcement:

1. Three parallel No. 9 stainless steel wires, tri-rod type, weld connected to No. 9 perpendicular cross wire at 16 inches on center.
2. Reinforcement: Clean and free from loose rust, scale, and any coatings that reduce bond.
3. Furnish special manufactured corner and wall intersection pieces at these locations.

E. Reglets for Masonry:

1. Manufacturers and Products:
   a. Superior Concrete Accessories, Franklin Park, IL; Superior Cushion Lock reglets Type B-3.
   b. Fry Reglet Corp., Glendale, CA; Fry Springlok Type MA.
   c. Chaney Flashing Co., Trenton, NJ; Type B reglet and snap lock cap flashing.

2.6 MORTAR PREPARATION

A. Place 1/2 the water and aggregate in the operating mixer; add cement; add the remaining aggregate and water and mix for at least 2 minutes. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after the addition of lime. Time the addition of admixture in strict accordance with the manufacturer's instructions and the procedure used for adding it to the mix shall provide good dispersion.

B. Mix mortar in machine with mixing drums clean and free of debris and dried mortar. Use mortar before the initial setting of the cement has taken place. Do not retemper mortar in which the cement has started to set.

C. Retemper mortar boards by adding water within a basin formed with the mortar and the mortar reworked into the water. Dashing or pouring water over mortar and retempering of harsh, nonplastic mortar is not permitted.

D. Where color tinting of mortar is required, add sufficient lime-proof color-fast mineral pigment to the mortar.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of masonry veneer.

B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Provide or cut special shapes for corners, jambs, lintels, and other areas as shown or as required. Match color and texture of standard units.

B. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

C. Matching Existing Masonry: Match coursing, bonding, color, and texture of new masonry with existing masonry.

3.3 BRICK VENEER INSTALLATION

A. General: Do not install cracked, broken, or chipped masonry units exceeding ASTM C216 allowances. Thoroughly wet brick just before laying except in freezing weather where bricks are laid dry. Prewetting may also be omitted if the brick at the time of laying has a rate of absorption not exceeding 0.025 ounce of water per square-inch of surface after being placed in 1/8-inch of water for 1-minute.

1. Coordinate installation with backup walls, through wall flashing, and other construction. Use masonry saws to cut and fit exposed units. Lay brick plumb, true to line, with level courses accurately spaced, and do not furrow bed joints.
2. Finish horizontal run by racking back in each course; toothing not permitted. Adjust all units to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and relay with fresh mortar.
3. Bond unexposed units in a wythe by lapping a minimum of 2 inches. Adjust shelf angles to keep Work level at proper elevation. Provide pressure relieving joints by placing a continuous 1/8-inch foam neoprene pad under the shelf angle.
4. When joining fresh masonry to set or partially set masonry:
   a. Remove loose brick and mortar.
   b. Clean and lightly wet exposed surface of set masonry prior to laying fresh masonry.

B. Pattern: Lay brick in running bond.

C. Mortar Beds: Lay brick with full mortar coverage on horizontal and vertical joints. Rock closures into place with head joints thrown against two adjacent bricks in-place. Do not pound corners or jambs to fit stretcher units after setting in-place. Where adjustment to corners or jambs must be made after mortar has started to set, remove mortar and replace with fresh mortar.

D. Horizontal and Vertical Face Joints:

1. Nominal Thickness: 3/8-inch.
2. Construct uniform joints.
3. Shove vertical joints tight.

4. Tool joints concave in exposed surfaces when thumbprint hard using jointing tool.
5. Concave tool exterior joints below grade.
6. Flush cut all joints not tooled.
7. Fill horizontal joints between top of masonry partition and underside of concrete beams with mortar.

E. Tuck-Point Joints:

1. Rake mortar joints to a depth of 1/2 to 3/4-inch.
2. Saturate exposed joints with clean water.
3. Fill joints solidly with pointing mortar.
4. Tool joints to match existing.

F. Movement Joints: Keep clean of all mortar and debris.

G. Masonry Control Joints:

1. Provide continuous vertical control joints in masonry as shown on Drawings.
2. Omit mortar from the vertical joints. Place the control joint material as the wall is built.

H. Through-Wall Flashing:

1. Place flashing on bed of mortar.
2. Lap and solder cross joints of through-wall flashing at least 4 inches.
3. Extend flashing beyond exterior face of wall and provide dripedge.
4. Cover flashing with mortar.

I. Flashing: Clean surface of masonry smooth and free from projections that might puncture, gouge, or otherwise damage flashing material.

J. Weep Holes: Provide weep holes in head joints in first course immediately above all flashing leaving head joint free and clean of mortar.

1. Maximum Spacing: 24 inches OC.
2. Keep weep holes and area above flashing free of mortar droppings.

K. Sealant Joints: Retain sealant joints around outside perimeters of exterior doors, window frames, and other wall openings:

1. Uniform Depth: 3/4-inch.
2. Uniform Width: 1/4-inch.

L. Nonreinforced Brick Masonry: Fill vertical, longitudinal joints by parging. Keep cavity in cavity walls clean:

1. Slightly bevel mortar bed to incline toward cavity. Place wood strips with attached wire pulls on metal ties.
2. Remove and clean wood strips prior to placing each succeeding row of metal ties.
3. As Work progresses, trowel all protruding fins in cavity flat on inner surface of wythe.

M. Anchoring: Anchor brick veneer to CMU backing with horizontal joint reinforcement and to metal studs and cementitious board backing with adjustable anchor ties.

1. Keep space free of mortar or other materials to permit differential movement between backing and masonry.
2. Attach brick veneer to backing with anchor ties.
   a. Use adjustable anchor tie for each 1.77 square feet of wall area.
   b. Maximum Space Between Adjacent Ties: 16 inches vertically and horizontally.
   c. Embed ties at least 2 inches in horizontal joint of brick veneer.
   d. Provide additional ties at openings:
      1) Maximum Spacing Around Perimeter: 24 inches.
      2) Install within 12 inches of opening.

N. Pointing: Cut out *defective* joints and holes in exposed masonry and repoint with mortar. Dry brush masonry surface after mortar has set at end of each day's Work and after final pointing.

3.4 SETTING CAST STONE

A. Clean stone immediately before setting.

B. Set each piece accurately, true to line, level and plumb, in full bed of fresh mortar. Completely fill all joints and beds with fresh mortar.

C. Install anchor system as shown.

D. After stones are set in mortar, do not move or disturb in any manner that might destroy bond between cast stone and mortar. Cast stones that have been disturbed shall be removed and reset in fresh mortar.

E. Keep faces of cast stone free of mortar. Promptly remove mortar splashed on stone faces and other surfaces. Rake joints and ends 3/4-inch deep for pointing or sealants at horizontal wash.

F. Upon completion, clean face of stone with stiff fiber brushes and detergent and water. Rinse thoroughly with fresh water.

3.5 CLEANING

A. Remove mortar stains with clear water as Work progresses.

B. Clean exposed unglazed masonry with stiff brush and clear water. If cleaning by water does not produce satisfactory results, apply cleaning agent to sample wall area of 20 square feet in location acceptable to the COTR/CM. Do not proceed with cleaning until sample area is acceptable to the COTR/CM.

C. Follow manufacturer's recommendations for use of cleaning agents.

D. Leave Work area and surrounding surfaces clean and free of mortar spots, droppings, and broken masonry.

3.6 FIELD QUALITY CONTROL

A. At least once a week while installation of masonry veneer is in progress, take mortar samples for testing. Continue on that basis for duration of installation of masonry veneer at the discretion of the COTR/CM.

B. Take samples in accordance with ASTM C270.

3.7 PROTECTION

A. Wall Covering: During erection, cover top of wall with strong waterproof membrane at end of each day or shutdown and as follows:

1. Cover partially completed walls when Work is not in progress.
2. Extend cover minimum of 24 inches down both sides.
3. Hold cover securely in-place.

B. Protect sills, ledges, and offsets from mortar drippings or other damage during construction. Remove misplaced mortar or grout immediately. Protect face materials against staining. Protect the door jambs and corners from damage during construction.

END OF SECTION

SECTION 05050
WELDING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Nondestructive Testing (ASNT): SNT-TC-IA, Personnel Qualification and Certification in Nondestructive Testing.
2. American Society for Testing & Materials (ASTM): A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
3. American Welding Society (AWS):
   a. B2.1, Specification for Welding Procedure and Performance Qualification.
   b. D1.1, Structural Welding Code - Steel.
   c. D1.3, Structural Welding Code - Sheet Steel.
   d. QC 1, Standard for AWS Certification of Welding Inspectors.

1.2 DEFINITIONS

A. CWI-Certified Welding Inspector.

B. NDT-Nondestructive Testing.

1.3 SUBMITTALS

A. Shop Drawings:

1. Shop and field welding procedure specifications (WPS).
2. Procedure qualification records (PQR).
3. Welding Documentation: Submit on appropriate forms in referenced welding codes.

B. Quality Control Submittals:

1. Welder/welding operator performance qualifications (WPQ).
2. Certified welding inspector (CWI) credentials.
3. Testing agency personnel credentials.
4. Welding inspector's report.

1.4 QUALIFICATIONS

A. Welding Inspector: Certified in accordance with AWS QC1, and having prior experience with the welding codes specified.

B. Testing Agency: Personnel performing tests shall be NDT Level II Certified in accordance with ASNT SNT-TC-1A.

1.5 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, all Submittals required in this Section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. The CWI shall be present whenever shop welding is performed. The CWI shall perform inspection before, during, and after welding. CWI duties include:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fit-up and in-process inspection.
5. Providing 100 percent visual inspection of all welds.
6. Supervising nondestructive testing personnel and evaluating test results.
7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

PART 3 EXECUTION

3.1 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in the attached Welding and Nondestructive Testing Table.

3.2 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Weld Inspection Criteria:

1. Selection of Welds to be Tested: As agreed upon between COTR/CM and CONTRACTOR.
2. Unless otherwise specified, perform NDT of welds at a spot testing frequency as shown below or in the attached table in accordance with the referenced welding codes as follows. In case there is a conflict the higher frequency level of NDT shall apply:
   a. Butt Joint Welds: 10 percent randomly radiographically tested and repaired.
   b. Groove Welds: 10 percent randomly ultrasonically tested and repaired.

c. Fillet Welds: 10 percent randomly examined and repaired, using either dye penetrant or magnetic particle inspection methods.
d. All Welds: 100 percent visually inspected.

3. Weld Acceptance:
   a. Visual Inspection (VT):
      1) Perform 100 percent VT of all welds.
      2) Structural Tubing: AWS D1.1, paragraph 6.9, Visual Inspection, Tubular Connections;
      3) All Other Structural Steel: AWS D1.1, paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
      4) Stud Connections: AWS D1.1, paragraph 7.8.1.
   b. Ultrasonic Testing (UT): Perform UT of groove welds in accordance with AWS D1.1, paragraph 6.13.3, Class R Indications.
   c. Radiographic Testing (RT): Perform RT of butt joint welds in accordance with AWS D1.1, paragraph 6.12.1.
   d. Magnetic Particle (MT):
      1) Perform on fillet and partial penetration groove welds in accordance with AWS D1.1, paragraph 6.10.
      2) Acceptance shall be in accordance with VT standards specified above.
   e. Liquid Penetrant (PT):
      1) Perform on fillet and partial penetration groove welds per AWS D1.1, paragraph 6.10.
      2) Acceptance shall be in accordance with VT standards specified above.

3.3 FIELD QUALITY CONTROL

A. The CWI shall be present whenever field welding is performed. CWI shall perform inspection before, during, and after welding. CWI duties include:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved welding procedure specifications (WPSs).
3. Monitoring conformance of welder/welding operator qualification (WPQs).
4. Providing 100 percent visual inspection of all welds.
5. Supervising nondestructive testing personnel and evaluating test results.
6. Maintaining records and preparing report confirming results of inspection and testing.

3.4 WELD DEFECT REPAIR

A. Repair and retest rejected weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.5 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.

1. Welding and Nondestructive Testing table.

END OF SECTION

WELDING AND NONDESTRUCTIVE TESTING						
Specification Section	**Governing Welding Codes or Standards**	**Submit Welding Procedure Spec.**	**Submit Welder/ Welding Operator Qual.**	**Onsite Welding Inspector Req'd**	**Submit Written Nondestructive Testing Procedure Specifications**	**Nondestructive Testing Requirements**
05120 STRUCTURAL STEEL	AWS D1.1, Structural Welding Code–Steel	Yes	Yes	No	No	100% VT(4); see Section 05120
05210 OPEN-WEB JOISTS	AWS D1.1, Structural Welding Code–Steel	Yes	Yes	No	No	100% VT(4); see Section 05210
05310 STEEL DECK	AWS D1.1, Structural Welding Code–Steel or AWS D1.3, Structural Welding Code–Sheet Steel	Yes	Yes	No	No	100% VT(4); see Section 05310
05500 METAL FABRICATIONS AND CASTINGS	AWS D1.1, Structural Welding Code–Steel or AWS D1.2, Structural Welding Code–Aluminum	No	No	No	No	10% UT(1) or RT(2) of all groove-and-butt joint welds; 10% MT(3) of all fillet welds; see Section 05500
05520 HANDRAILS	AWS D1.1, Structural Welding Code–Steel or AWS D1.2, Structural Welding Code–Aluminum	No	No	No	No	100% VT(4); see Section 05520

(1)UT–Ultrasonic Testing.
(2)RT–Radiographic Testing.
(3)MT–Magnetic Particle Testing.
(4)VT–Visual Testing

SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Institute of Steel Construction (AISC):
   a. Specification for Structural Steel Buildings—Allowable Stress Design and Plastic Design, excluding Section A7.1.
   b. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.
   c. Manual of Steel Construction, Allowable Stress Design.
   d. Code of Standard Practice for Steel Buildings and Bridges, excluding Sections 3, 4, 7.11.3.3, 7.11.4, 7.11.5, and 7.13.
   e. AISC Quality Certification Program.
   f. AISC Erector Certification Program.
2. American Society for Testing and Materials (ASTM):
   a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Steel Piling.
   b. A36, Standard Specification for Structural Steel.
   c. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   d. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   e. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   f. A325, Standard Specification for High-Strength Bolts for Structural Steel Joints.
   g. A490, Standard Specification for Heat-Treated Steel Structural bolts, 150 ksi Minimum Tensile Strength.
   h. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   i. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   j. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   k. A572, Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
   l. A588, Standard Specification for High-Strength Low Alloy Structural Steel With 50 ksi Minimum Yield Point to 4 in. Thick.
   m. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

n. A992, Standard Specification for Steel for Structural Shapes for Use in Building Frames.
o. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
p. F436, Standard Specification for Hardened Steel Washers.
q. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
r. F1852, Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/150 ksi Minimum Tensile Strength.

3. American Welding Society (AWS): D1.1, Structural Welding Code-Steel.

1.2 SUBMITTALS

A. Shop Drawings:

1. Provide details showing:
   a. Erection plans.
   b. Members and their connections.
   c. Anchor bolt layouts.
   d. Hardened washer details.
   e. Joint details for complete penetration welds.
   f. Schedules for fabrication procedures.
2. Name and address of manufacturer(s).
3. Product specifications.
4. Manufacturers' testing procedures and standards.
5. Preparation and installation or application instructions, as appropriate.

B. Quality Control Submittals:

1. Mill Certificates of tests made in accordance with ASTM A6.
2. High-Strength Bolts (Plain Noncoated and Hot-Dip Galvanized):
   a. Certificates of Compliance that products meet chemical and mechanical requirements of standards specified.
   b. Manufacturer's inspection test report results for production lot(s) furnished, to include:
      1) Tensile strength.
      2) Yield strength.
      3) Reduction of area.
      4) Elongation and hardness.
   c. Certified Mill Test Reports for Bolts and Nuts:
      1) Name and address of manufacturer.
      2) Bolts correctly marked.
      3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.

3. Direct Tension Indicators (DTIs): Furnish manufacturer's test report meeting requirements of ASTM F959.
4. Tension Control (TC) Bolts: Furnish manufacturer’s test report meeting requirements of ASTM A325 and ASTM F1852.
5. Methods proposed to resolve misalignment between anchor bolts and bolt holes in steel members.
6. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05050, WELDING.

1.3 QUALITY ASSURANCE

A. Mill identification marks in accordance with ASTM A6.

B. Welding Qualifications: As specified in Section 05050, WELDING.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.

B. Storage:

1. Protect structural steel members and packaged materials from corrosion and deterioration.
2. Store in dry area and not in direct contact with ground.
3. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.

C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.1 MATERIALS

A. Rolled Plates, Shapes, and Bars: ASTM A36, unless indicated otherwise.

B. W-Shapes:

1. ASTM A572, Grade 50 per AISC Technical Bulletin No. 3, March 1997 (ASTM A992), where indicated on Drawings.

C. Square and Retangular Hollow Structural Sections (HSS): ASTM A500, Grade B (Fy equals 46 ksi).

2.2 FASTENERS

A. Anchor Bolts: As specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

B. High-Strength Bolts: ASTM A325 or ASTM A490, bolt type 1, plain uncoated. Bolt length and thread length shall be as required for the connection type shown, with hardened washers as required.

C. Nuts: ASTM A563, type to match bolt type and finish.

D. Hardened Steel Flat and Beveled Washers: ASTM F436, type to match bolt finish.

E. Welded Shear Studs: As specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

2.3 ANCILLARY MATERIALS

A. Surface Preparation and Primer: As specified in Section 09900, PAINTING.

B. Grout: As specified in Section 03301, REINFORCED CONCRETE.

2.4 FABRICATION

A. General:

1. Fabricate as shown and in accordance with AISC Specification For Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges.
2. Columns shall be full length members without splices.
3. Mark and match mark materials for field assembly.
4. Complete assembly, including bolting and welding of units, before start of finishing operations.
5. Fabricate to agree with field measurements.
6. Provide camber as indicated on Drawings.

B. Connections:

1. Shop Connections: Weld or bolt, as shown.
2. Meet requirements of AISC Manual of Steel Construction tables for bolted double-angle shear connections, unless indicated otherwise.

C. Welded Construction:

1. As specified in Section 05050, WELDING.
2. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

D. Interface With Other Work:

1. Holes:
   a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.
   b. No flame-cut holes will be permitted without prior approval of COTR/CM.
2. Weld threaded nuts to framing, and other specialty items as shown to receive other Work.

E. Architecturally Exposed Structural Steel (AESS): Fabricate in accordance with Section 10, AISC Code of Standard Practice for Steel Buildings and Bridges.

F. Shop Paint Primer:

1. Surface Preparation and painting as specified in Section 09900, PAINTING.
2. Do not shop prime the following surfaces, unless indicated otherwise:
   a. Faying surfaces of slip critical bolted connections.
   b. Within 2 inches of field-welded connections.
   c. Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.
3. Apply shop primer to top flange surfaces of composite steel beams unless indicated otherwise.

2.5 SOURCE QUALITY CONTROL

A. Welding:

1. Visually inspect fabrication welds in accordance with AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Repair and retest defective welds as specified in Section 05050, WELDING.

PART 3 EXECUTION

3.1 ERECTION

A. Meet requirements of AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges, with exceptions as specified.

B. Install CONTRACTOR-designed temporary construction bracing to provide necessary support until components are in place and construction is complete.

C. High-Strength Bolted Connections:

1. Tighten in accordance with AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
2. Hardened Washers:
   a. Provide at locations required by Washer Requirements section of AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
   b. Use beveled style and extra thickness where required by AISC Specification.
   c. Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.
3. For bearing-type connections not fully tensioned (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.

3.2 ANCHOR BOLTS

A. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.

B. Provide templates and other devices for presetting bolts and other anchors to accurate locations.

3.3 SETTING BASES AND BEARING PLATES

A. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.

B. Clean bottom surface of base and bearing plates.

C. Set loose and attached baseplates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices.

D. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout.

E. Grout Under Baseplates: Category II, as specified in Section 03301, REINFORCED CONCRETE, prior to placing loads on structure.

3.4 FIELD ASSEMBLY

A. Set structural frames accurately to lines and elevations shown.

B. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.

C. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.

D. Level and plumb individual members of structure within tolerances shown in AISC Code of Standard Practice for Steel Buildings and Bridges.

E. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.

F. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

G. Provide additional field connection material as required by AISC Code of Standard Practice for Steel and Bridges.

H. Splice members only where indicated and accepted on shop drawings.

I. Architecturally Exposed Structural Steel (AESS): Erect in accordance with Section 10, AISC Code of Standard Practice for Steel Buildings and Bridges.

3.5 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify COTR/CM for approval of one of the following methods of correction:

1. Ream holes that must be enlarged to admit bolts and use oversized bolts.
2. Plug weld misaligned holes and redrill holes to admit standard size bolts.
3. Drill additional holes in connection, conforming with AISC Standards for bolt spacing and end and edge distances, and add additional bolts.
4. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.

B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

3.6 MISFITS AT ANCHOR BOLTS

A. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved submittal.

B. Do not flame cut to enlarge holes.

3.7 GAS CUTTING

A. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.

B. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by COTR/CM.

C. Finish flame-cut sections equivalent to sheared and punched appearance.

3.8 REPAIR AND CLEANING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop primer.

B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.

C. Remove weld back-up bars and grind smooth where indicated on Drawings.

D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09900, PAINTING.

3.9 FIELD QUALITY CONTROL

A. Welded Connections

1. An independent testing agency will be retained by COTR/CM to perform the following inspection and testing of field welds as specified in Section 05050, WELDING.
   a. All Welds: 100 percent visually inspected (VT).
2. Repair and retest defective welds as specified in Section 05050, WELDING.

B. Welded Anchor Studs

1. Inspect and test welded shear studs as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

END OF SECTION

SECTION 05210
OPEN-WEB STEEL JOISTS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction (AISC):
   a. Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design.
   b. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.
   c. Code of Standard Practice for Steel Buildings and Bridges.
2. American Welding Society (AWS): D1.1, Structural Welding Code - Steel.
3. Steel Joist Institute (SJI):
   a. Standard Specifications and Load Tables:
      1) Open-Web Steel Joists, K-Series.
   b. Recommended Code of Standard Practice for Steel Joists and Joist Girders.

1.2 SUBMITTALS

A. Shop Drawings:

1. Plan view layout of joists and bridging.
2. Elevation view of each type of joist showing configuration, chord and web member sizes, panel point dimensions, and chord extensions.
3. Connection and bearing details.
4. Special joist reinforcing and connections for supported items, such as mechanical equipment.
5. Bridging member sizes and connection details.
6. Complete design, including stress and deflection calculations, for joists, joist members, and connections for design load and equipment weight as indicated, plus any construction loads applied by CONTRACTOR's operations.
7. Calculations shall include check of joist chord bending stresses for concentrated loads applied between panel points.
8. Registered Professional Engineer's stamp, valid in same state as Project, on design drawings and stress calculations.
9. Procedure for handling, erection, and bracing of steel joists.

B. Quality Control Submittals:

1. Joist manufacturer's installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05050, WELDING.

1.3 QUALITY ASSURANCE

A. General: Design and fabricate steel joists and bridging to meet requirements of SJI Standard Specifications and Load Tables.

B. Certification: SJI Membership, with certification for joist types as indicated on Drawings.

C. Qualifications for Field Welding: As specified in Section 05050, WELDING.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Protect joist paint system from abrasion at steel bands and other joists.

C. Store joists and bridging off ground on wood sleepers.

D. Support joists so there is no danger of tipping, sliding, rolling, shifting or material damage.

PART 2 PRODUCTS

2.1 STEEL JOISTS AND BRIDGING

A. Provide type of joist, chord configuration, and depth as indicated on Drawings.

B. Design and Manufacture:

1. In accordance with the applicable SJI Standard Specifications.
2. Chord Members: Rolled double angle sections only.
3. Provide the following where indicated, in accordance with SJI Standard Specifications and Load Tables:
   a. Bottom chord bracing and end anchorage for uplift design criteria.
   b. Ceiling extension to within 1 inch of finished wall surface, unless otherwise indicated.
   c. Top chord extension, R type,unless otherwise indicated.
   d. Full camber, unless otherwise indicated.

C. Joist Bridging:

1. In accordance with applicable SJI Standard Specifications for type of joist.
2. Furnish bridging of minimum size and type as indicated.
3. Provide anchorage connection to walls and girders at bridging lines as indicated.

2.2 SHOP PRIMER

A. Surface Preparation and Primer: As specified in Section 09900, PAINTING.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel joists.

3.2 INSTALLATION

A. Erection: SJI Standard Specifications and approved shop drawings.

B. Welded Connections: As specified in Section 05050, WELDING.

3.3 TOUCHUP PAINTING

A. Immediately following erection, remove debris from completed installation.

B. Clean field welds, bolted connections, rust spots, and abraded areas.

C. Repair damaged painted surfaces as specified in Section 09900, PAINTING.

3.4 FIELD QUALITY CONTROL

A. Welding:

1. An independent testing agency will be retained by COTR/CM to visually inspect field welded connections in accordance with AWS D1.1, Table 6.1, and as specified in Section 05050, WELDING.
2. Repair defective welds as specified in Section 05050, WELDING.

END OF SECTION

SECTION 05310
STEEL DECK

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Iron and Steel Institute (AISI): Specifications for the Design of Cold Formed Steel Structural Members.
2. American Society for Testing and Materials (ASTM):
   a. A611, Standard Specification for Structural Steel (SS), Sheet, Carbon, Cold-Rolled.
   b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   d. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
3. American Welding Society (AWS): D1.3, Structural Welding Code - Sheet Steel.
4. Steel Deck Institute (SDI):
   a. Design Manual for Composite Decks, Form Decks and Roof Decks.
   b. Diaphragm Design Manual.
5. Factory Mutual (FM):
   a. Factory Mutual Approval Guide.
   b. FM Research Corporation (FMRC): Approval Requirements for Steel Roof Deck Construction.
6. International Conference of Building Officials (ICBO): Evaluation Reports for Deck Fasteners.
7. Underwriters Laboratories, Inc. (UL): Fire Resistance Directory.

1.2 SUBMITTALS

A. Shop Drawings:

1. Plan view layout of decking showing type and section properties of deck panels, reinforcing channels, pans, special jointing, and accessories.
2. Location of openings, deck laps, and deck attachment details.

B. Quality Control Submittals:

1. Decking manufacturer's installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05050, WELDING.
3. Operation manuals for mechanical fastener installation tools.
4. Manufacturer's Certificate of Compliance, in accordance with Section 01300, SUBMITTALS.

1.3 QUALITY ASSURANCE

A. General: For metal decking section properties, meet requirements of AISI Specifications for Design of Cold-Formed Steel Structural Members.

B. FM Requirements:

1. Steel Roof Deck: Listed in Factory Mutual "Approval Guide" for Class 1 fire rating and Class 1-90 wind uplift rating.
2. Mechanical Fasteners: Packing containers shall show name of manufacturer and product and FMRC approval mark.

C. Qualifications for Field Welding: As specified in Section 05050, WELDING.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store deck bundles on platforms or pallets, with one end elevated to provide drainage.

C. Protect bundles against condensation with a ventilated waterproof covering.

D. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage.

E. Architecturally exposed deck shall be appropriately packaged and protected to prevent damage during shipment.

PART 2 PRODUCTS

2.1 METAL DECKING

A. Provide metal deck as shown in the following schedule:

STEEL DECK SCHEDULE								
Type	**Depth (in)**	**Panel Width (in)**	**Gauge**	**Min. Yield Point Fy (ksi)**	**Min. (+) S (in^3/ft)**	**Min. I (in^4/ft)**	**Minimum Diaphragm Shear Capacity (lbs/ft)**	**Finish**
Roof Deck	1-1/2	36	20	33	0.23	0.21	300	Galv, G-60
Composite Floor Deck	2	36	18	40	0.51	0.56	1,600	Galv, G-60
Noncomposite Form Deck	1 ½	36	20	33	.247	.201	1,600	Galv, G-60

B. Materials and Finishes:

1. Galvanized Deck:
   a. Sheet steel for galvanized deck and accessories shall conform to ASTM A653 Structural Quality Grade 33 or higher, as shown in Steel Deck Schedule.
   b. Galvanizing shall conform to ASTM A924 with coating class of G60 or G90 as defined in ASTM A653 and as shown in Steel Deck Schedule.

C. Manufacturers:

1. Vulcraft Division of Nucor Co., Brigham City, UT.
2. BHP Steel Building Products, USA, Inc., West Sacramento, CA.
3. Verco Manufacturing, Inc., Phoenix, AZ.
4. United Steel Deck, Inc., Summit, NJ.

2.2 ACCESSORIES

A. Provide pour stops, column closures, end closures, cover plates, girder fillers, ridge and valley plates, finish strips, reinforcing channels, and other accessories as indicated for complete installation.

B. Accessories shall comply with requirements of SDI and deck manufacturer.

2.3 MECHANICAL FASTENERS

A. Self-Drilling Screws:

1. Self-drilling, self-tapping screws with hexagonal washer head and corrosion-resistant finish.

2. Manufacturers and Products:
   a. ITW Buildex, Itasca, IL; ICH Traxx Self-Drilling Fasteners with Climaseal Coating and Autotraxx Standup Installation Tool.
   b. Hilti, Inc., Tulsa, OK; Kwik-Pro HWH Self-Drilling Screws with Kwik-Cote Treatment and Kwik-Tapper Screwdriver.

2.4 SHEAR CONNECTORS FOR COMPOSITE DECK:

A. Welded headed anchor studs: Size and spacing as indicated on Drawings and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.

3.2 INSTALLATION

A. Locate deck bundles to prevent overloading of support framing members.

B. Install at right angles to supporting members, unless shown otherwise, and in accordance with specifications and manufacturer's installation recommendation.

C. Bearing: 1-1/2 inches, minimum.

D. Endlaps: Minimum of 2 inches and located over supports.

E. Do not stretch sidelaps.

F. Closure Plates:

1. Install closure and cover plate accessories as recommended by SDI.
   a. Fasten column closures, cell closures, and zee closures to deck to provide tight fitting closures at open ends of ribs and sides of decking.
   b. Fasten cell closures at changes of direction of deck units unless otherwise indicated.

G. Holes and Openings

1. Cut and fit around roof openings and other work projecting through or adjacent to decking.

2. Locate holes and openings as shown to clear structural framing and bracing members.
3. Reinforcement around openings:
   a. Roof Deck: For hole sizes of at least 6 inches across, but not more than 12 inches across in roof deck, reinforce with 18 gauge steel plate, painted or galvanized to match deck coating. Extend plate at least 12 inches beyond opening in all directions and attach to top of roof deck with No. 10 self-drilling screws at 6-inch spacing and at all corners. For openings larger than 12 inches across, reinforce roof deck with framing as shown on Drawings.
   b. Composite Floor Deck and Form Deck: Reinforce openings as indicated on Drawings.

H. Protect deck areas from heavy concentrated loads with planking or other approved means.

I. Install temporary shoring, if required, to meet strength and deflection limitations, before placing any concrete topping on deck panels.

J. Completed Deck: Free from buckles and irregularities, and in accordance with FM and UL requirements.

3.3 DECK ATTACHMENT

A. Fasten panels as shown in the following schedule:

STEEL DECK ATTACHMENT SCHEDULE							
		At Perpendicular Supports		At Parallel Supports		At Sidelaps	
Type	Depth (in.)	Type	No. Per Sheet	Type	Spacing (in.)	Type	Spacing (in.)
Roof Deck	1-1/2	#12 Self-drilling screws	3	#12 Self-drilling screws	12	#10 Self-drilling screws	20
Composite Floor Deck	2	#12 Self-drilling screws	3	#12 Self-drilling screws	12	#10 Self-drilling screws	20
Noncomposite Form Deck	1 ½	#12 Self-drilling screws	5	#12 Self-drilling screws	12	#10 Self-drilling screws	18

B. Mechanical Fasteners:

1. Self-Drilling Screws:
   a. Install screws in accordance with manufacturer's written instructions and with special installation tool. Do not over-torque.
   b. Remove and redrive screws at sidelaps where upper sheet is not drawn tightly against lower sheet.

3.4 TOUCHUP PAINTING

A. Immediately following erection, remove unused deck edge trimmings, screws, fasteners, and debris from completed installation.

B. Clean bolted connections, rust spots, and abraded areas.

C. Repair damaged painted surfaces as specified in Section 09900, PAINTING,.

D. Repair damaged galvanized surfaces with zinc-rich spray paint in accordance with ASTM A780; color to match galvanized deck.

E. Use magnetic gauge to determine that thickness of repair is equal to or greater than base painted or galvanized coating.

3.5 FIELD QUALITY CONTROL

A. An independent testing agency shall be retained by COTR/CM to perform following inspections.

1. Welded Connections: Visually inspect in accordance with AWS D1.3, Section 7, and as specified in Section 05050, WELDING.
2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer's instructions, for each type of fastener.

B. Repair or replace defective welds and fasteners.

C. Welded Shear Studs: Inspect and test as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

END OF SECTION

SECTION 05500
METAL FABRICATIONS AND CASTINGS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. The Aluminum Association, Inc. (AA): Construction Manual 30, Specifications for Aluminum Structures, Fifth Edition.
2. American Galvanizers Association (AGA): Inspection of Products Hot-Dip Galvanized After Fabrication.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Institute of Steel Construction (AISC):
   a. Specification for Structural Steel Buildings—Allowable Stress Design and Plastic Design.
   b. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.
   c. Code of Standard Practice for Steel Buildings and Bridges.
   d. AISC Quality Certification Program.
5. American National Standards Institute (ANSI):
   a. A14.3, Ladders, Fixed, Safety Requirements.
   b. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
6. American Society for Testing and Materials (ASTM):
   a. A36, Standard Specification for Structural Steel.
   b. A48, Standard Specification for Gray Iron Castings.
   c. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   d. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   e. A143, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement.
   f. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   g. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   h. A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
   i. A240, Standard Specification for Heat-Resisting Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

j. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
k. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
m. A325, Standard Specification for High-Strength Bolts for Structural Steel Joints.
n. A384, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
o. A385, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
p. A489, Standard Specification for Carbon Steel Eyebolts.
q. A490, Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.
r. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
s. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
t. A653, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated Galvannealed) by the Hot-Dip Process.
u. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
v. A786, Standard Specification for Rolled Steel Floor Plates.
w. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
x. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
y. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Shapes.
z. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
aa. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
bb. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
cc. F436, Standard Specification for Hardened Steel Washers.
dd. F468, Standard Specification for Nonferrous Nuts for General Use.
ee. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ff. F594, Standard Specification for Stainless Steel Nuts.

gg. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

7. American Welding Society (AWS):
   a. D1.1, Structural Welding Code-Steel.
   b. D1.2, Structural Welding Code-Aluminum.
8. International Conference of Building Officials (ICBO): Evaluation Reports for Concrete and Masonry Anchors.
9. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.2 DEFINITIONS

A. Submerged: Location at or below top of wall of open water-holding structure, such as a basin, channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior below-grade wall or roof surface of water-holding structure, open or covered.

B. Exterior Area: Location not protected from the weather by a building or other enclosed structure.

C. Interior Wet Area: Location inside a building or structure where the floor is sloped to floor drains or gutters and is subject to liquid spills or washdown.

D. Interior Dry Area: Location not subject to liquid spills or washdown.

E. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

1.3 SUBMITTALS

A. Shop Drawings:

1. Metal fabrications, including welding and fastener information.
2. Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Samples: Color samples of abrasive stair nosings.

C. Quality Control Submittals:

1. Concrete and Masonry Drilled Anchors:
   a. Manufacturer's product description and installation procedures.

b. Current test data or ICBO evaluation report.
c. Adhesive Anchor Installer Certification.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following the procedures of the Quality Assurance Manual of the American Galvanizers Association.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:

1. Insofar as practical, factory assemble items specified herein.
2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled, in a manner that will protect materials from damage, and facilitate identification and field assembly.

B. Storage of Adhesive:

1. Store adhesive cartridges on pallets or shelving in a covered storage area.
2. Control storage temperature in accordance with manufacturer's written instructions.
3. Dispose of cartridges if shelf life has expired.

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Shapes and Plates	A36, A572
Steel Pipe	A501 or A53, Type E or S, Grade B
Structural Steel Tubing	A500, Grade B
Stainless Steel:	
Bars	A276, AISI Type 316
Shapes	A276, AISI Type 304
Steel Plate, Sheet, and Strip	A240, AISI Type 316

Item	ASTM Reference
Bolts and Threaded Rods	F593, AISI Type 316
Nuts	F594, AISI Type 316
Steel Bolts and Nuts:	
Carbon Steel	A307 or A36
High-Strength	A325, Type 1
Galvanized Steel Bolts and Nuts	A307 or A36, with A153 Zinc Coating, and ANSI B1.1
Eyebolts	A489
Threaded Rods	A36
Flat Washers (Unhardened)	F844; use A153 for Zinc Coating
Flat Washers (Hardened)	F436
Welded Anchor Studs	A108, Grades C-1010 thru C-1020
Aluminum, Structural Shapes, and Plates	B209 and B308, Alloy 6061-T6
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48, Class 35

2.2 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Anchor Bolts:

1. Cast in place.
2. Headed type, unless otherwise shown on Drawings.
3. Material type and protective coating as shown in FASTENER SCHEDULE at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated Sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High density polyethylene.
   d. Manufacturer: Sinco West, Simi Valley, CA.
2. Fabricated Steel: ASTM A36.

2.3 CONCRETE AND MASONRY DRILLED ANCHORS

A. General:

1. AISI Type 316 stainless, galvanized, or zinc-coated steel. Refer to FASTENER SCHEDULE at end of this section.
2. Current evaluation and acceptance reports by ICBO or other similar code organization.
3. Acceptable for use in potable water structures by EPA and local health agencies or NSF.

B. Wedge Anchors:

1. Manufactures and Products:
   a. ITW Ramset/Red Head, Wood Dale, IL; Trubolt Wedge Anchor.
   b. Hilti, Inc., Tulsa, OK; Kwik-Bolt II Stud Anchor.
   c. Powers Rawl, New Rochell, NY; Power-Stud Anchor.
   d. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Wedge-All Anchor.
   e. Wej-It Corp., Tulsa, OK; ANKRtite Wedge Anchor.
   f. U.S. Anchor, Pompano Beach, FL; Kingpin Wedge Anchor.

C. Expansion Anchors:

1. Self-drilling anchors, snap-off or flush type, zinc-coated.
2. Nondrilling Anchors: Flush type for use with zinc-coated or stainless steel bolt, or stud type with projecting threaded stud.
3. Manufacturers and Products:
   a. ITW Ramset/Red Head, Wood Dale, IL; Multi-Set II Drop-In and Self Drill Anchor.
   b. Hilti, Inc., Tulsa, OK; Hilti HDI Drop-In Anchor.
   c. Powers Rawl, New Rochelle, NY; Steel Drop-In Anchor.
   d. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Drop-In Anchor.

D. Undercut Anchors:

1. Manufacturer and Product: Covert Operations, Inc., Long Beach, CA; DUC Undercut Anchor.

E. Sleeve Anchors:

1. Manufacturers and Products:
   a. ITW Ramset/Red Head, Wood Dale, IL; Dynabolt Hex Nut Sleeve Anchor.
   b. Powers Rawl, New Rochelle, NY; Hex Head Power-Bolt Anchor.

c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Sleeve-All Hex Head Anchor.
d. Wej-It Corp., Tulsa, OK; Wej-It Sleeve Anchor.

F. Adhesive Anchors:

1. Anchor Rod:
   a. Stainless steel threaded rod, diameter as shown on Drawings.
   b. Length as required to provide minimum depth of embedment.
   c. Clean and free of grease, oil, or other deleterious material.
   d. For hollow-unit masonry, provide galvanized steel wire cloth screen tube to fit threaded rod.
2. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments, with gray color after mixing.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
   c. Nonsag, with selected viscosity base on installation temperature and overhead application where applicable.
3. Packaging:
   a. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
   b. Cartridge Markings: Include manufacturer's name, product name, material type, batch or serial number, and adhesive expiration date.
4. Manufacturers and Products:
   a. ITW Ramset/Red Head, Wood Dale, IL; Epcon Ceramic 6 Epoxy Anchor System.
   b. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System (HIT HY-150).
   c. Powers Rawl, New Rochelle, NY; Power Fast Epoxy Injection Gel Cartridge System.
   d. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Epoxy-Tie Adhesive ET22.
   e. Covert Operations, Inc., Long Beach, CA; CIA-Gel 7000 Epoxy Anchors.
5. Welded Anchor Studs
   a. Headed anchor studs (HAS) or threaded anchor studs (TAS), as indicated on Drawings.
      1) Carbon Steel: ASTM A108, Grades 1010 through 1020, unless indicated otherwise.
   b. Manufacturers:
      1) Nelson Stud Welding, FabriSteel Co., Elyria, OH.
      2) Stud Welding Associates, Inc., Elyria, OH.

2.4 PIPE SLEEVES

A. ASTM A53, Schedule 40 steel pipe sleeves with continuously welded 3/16-inch thick seep ring with outside diameter 3 inches greater than sleeve outside diameter. Galvanize in accordance with ASTM A123.

2.5 STEEL SHELF ANGLES

A. ASTM A36, galvanize after fabrication in accordance with ASTM A123.

2.6 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Fabricate aluminum in accordance with AA Construction Manual 30.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Steel:
   a. Meet fabrication requirements of AWS D1.1, Chapter 5.
   b. Meet visual acceptance standards of AWS D1.1, Table 6.1.
3. Aluminum: Meet requirements of AWS D1.2.
4. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09900, PAINTING unless otherwise noted.
2. For items to be embedded in concrete, coat with System No. 2 as specified in Section 09900, PAINTING.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143, A384, and A385. Avoid fabrication techniques which could cause distortion or embrittlement of the steel.
2. Remove welding slag, splatter, burrs, grease, oil, paint, and other deleterious material prior to delivery for galvanizing.
3. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
4. Galvanize steel members, fabrications, and assemblies after fabrication by the hot-dip process in accordance with ASTM A123.
5. Galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153.
6. Galvanized steel sheets in accordance with ASTM A653.
7. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.
8. Except for inlet grates not otherwise required to be welded, completely seal edges of tightly contacting surfaces, where galvanizing is required, by welding before galvanizing.

F. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

G. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.7 ABRASIVE NOSING FOR STAIRS

A. Unless otherwise shown on Drawings, furnish flush type abrasive nosings on stairs.

B. Nosing Components:

1. Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.
2. Epoxy abrasive shall extend over and form curved front edge of nosing.
3. Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.

C. Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

D. Size: 3 inches wide by ¼ to 3/8 inch thick by length as shown.

E. Color: Grey.

F. Manufacturers and Products:

1. Wooster Products, Inc., Wooster, OH Spectra Type WP3J.
2. American Safety Tread Co., Inc., Helena, AL.

PART 3 EXECUTION

3.1 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb or level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Erect steel in accordance with AISC Code of Standard Practice for Steel Buildings and Bridges.
4. Install manufactured products in accordance with manufacturer's recommendations.
5. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
6. Perform field welding in accordance AWS D1.1.
7. Obtain COTR/CM approval prior to field cutting steel members or making adjustments not scheduled.

B. Erection Tolerances:

1. Maximum Variation from Plumb: 1/4-inch per story, non-cumulative.
2. Maximum Offset from True Alignment: 1/4-inch.

C. Aluminum:

1. Erection: In accordance with AA Construction Manual 30.
2. Do not remove mill markings from concealed surfaces.
3. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.

D. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide a center flange for water stoppage on sleeves in exterior or water-bearing walls.

4. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

E. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on Drawings.

3.2 ANCHOR BOLTS

A. Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

B. Use sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12-inches long, unless otherwise shown.

3.3 CONCRETE AND MASONRY DRILLED ANCHORS

A. Begin installation only after concrete or masonry to receive anchors has attained design strength.

B. Do not install an anchor closer than six times its diameter to an edge of concrete or masonry or closer than twelve diameters to another anchor, unless shown otherwise.

C. Install in accordance with manufacturer's instructions.

D. Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air.

E. For undercut anchors, use only special undercutting drill bit and rotary hammer drill as recommended by anchor manufacturer.

F. When embedded steel or rebar is encountered in the drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction, notify COTR/CM for direction on how to proceed.

G. Do not install when temperature of concrete is below 40 degrees F or above 100 degrees F.

3.4 ELECTROLYTIC PROTECTION

A. Aluminum:

1. Where in contact with dissimilar metals, or embedded in masonry or concrete, protect surfaces as specified in Section 09900, PAINTING, System No. 27.
2. Allow coating to dry before installation of the material.
3. Protect coated surfaces during installation.
4. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Painted Galvanized Surfaces: Prepare as specified in Section 09900, PAINTING, System No. 10, Galvanized Metal Conditioning.

C. Repair of Damaged Galvanized Coating: Repair damaged areas greater than 3/16 inch in width in accordance with ASTM A123 and ASTM A780.

3.5 FASTENER SCHEDULE

A. Provide fasteners as follows:

Service Use and Location	**Product**	**Remarks**
1. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bond coating, unless otherwise specified with equipment	See System No. 29, Section 09900, PAINTING
2. Anchor Bolts Cast Into Concrete for Metal Fabrications and Structural Components		
Interior Dry Areas	Zinc-coated steel headed anchor bolts	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bond coating	See System No. 29, Section 09900, PAINTING

Service Use and Location	Product	Remarks
3. Drilled Anchors for Metal Components to Concrete (e.g., Electrical Panels and Equipment)		
Interior Dry Areas	Zinc-coated or stainless steel wedge or expansion anchors	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	
4. Anchors in Grout-Filled Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Galvanized steel headed anchor bolts, zinc-coated or stainless steel sleeve anchors, or stainless steel adhesive anchors	
5. Anchors in Hollow Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Zinc-coated or stainless steel sleeve anchors, or stainless steel adhesive anchors with screen tube	
6. Connections for Structural Steel Components		
Exterior and Interior Wet and Dry Areas	High-strength zinc-coated steel bolts	See Section 05120, STRUCTURAL STEEL
7. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolts	
8. All Others		

Service Use and Location	Product	Remarks
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Anti-seizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

3.6 FIELD QUALITY CONTROL

A. Galvanizing:

1. Visually inspect and test thickness of zinc coating in accordance with ASTM A123 and A153.

B. Welded Anchor Studs:

1. At start of each production period, CONTRACTOR shall perform the following test to determine proper generator, control unit, and stud welding gun settings, in accordance with AWS D1.1, Chapter 7.
   a. Weld two test studs and visually inspect for full 360-degree flash.
   b. Bend test studs 30 degrees from vertical.
   c. Test studs will be acceptable if there is no failure of welds.
   d. If weld fails, repeat test until two consecutive test studs test to be satisfactory.
2. During production, where weld does not exhibit full 360-degree flash, CONTRACTOR shall perform the following test in accordance with AWS D1.1, Chapter 7.
   a. Bend stud approximately 15 degrees from vertical, away from missing portion of flash.
   b. Studs meeting this test without exhibiting cracks in weld will be considered acceptable and left in bent position.
   c. Replace studs failing test.

3.7 ABRASIVE NOSINGS

A. Provide abrasive nosings on concrete steps not being supplied or coated with another type of nosing or nonskid material.

END OF SECTION

SECTION 05520
HANDRAILS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Aluminum Association, Incorporated (AA): 45, Designation System for Aluminum Finishes.
2. American Iron and Steel Institute (AISI): SS306, Stainless Steel for Building Exteriors.
3. American Society for Testing and Materials (ASTM):
   a. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
4. Building Officials and Code Administrators International (BOCA): National Building Code (NBC).
5. International Conference of Building Officials (ICBO): 1991, Uniform Building Code (UBC).
6. Occupational Safety and Health Act (OSHA): 29 CFR 19.10, Code of Federal Regulations.

1.2 DEFINITIONS

A. Handrails: Synonymous with terms, i.e., ornamental railing, guardrail, railing system. Handrails are comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

B. Toeboards: Not required.

1.3 SUBMITTALS

A. Shop Drawings:

1. Indicate handrail profiles, sizes, connections, embeds, anchorage, size and type of fasteners, and accessories. Project-specific scale plans and elevations of handrails.
2. Manufacturer's literature and catalog data of handrail and components.
   a. Design Data: Structural calculations or test data using design performance loads demonstrating components meet or exceed all applicable building codes and OSHA requirements.

B. Quality Control Submittals:

1. Manufacturer's assembly and installation instructions.
2. Manufacturer's written recommendations describing procedures for maintaining handrails including cleaning materials, application methods, and precautions to be taken in the use of cleaning materials.
3. Test Reports: Test data may supplement load calculations providing data covers the complete handrail system, including anchorage:
   a. Test data for handrail and components showing load and deflection due to load, in enough detail to prove handrail is strong enough and satisfies national, State of Ohio and local standards, regulations, code requirements, and OSHA 29 CFR 19.10, using design loads specified. Include test data for the following:
      1) Railing and post connections.
      2) Railing wall connections.
      3) Post and base connections.
   b. Deflection Criteria: In accordance with ASTM E985 and design loads specified.
   c. Aluminum Rail Piping: Test data showing yield strength of pipe as-delivered equals or exceeds 35,000 psi.
   d. Concrete Anchors: Calculations and test data for review prior to use, on anchors other than those specified.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handrails adequately packaged and wrap to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping until railing is completely installed.

B. Aluminum Handrails:

1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
2. All clear anodized handrail pipe and posts delivered with protective plastic wrap.

PART 2 PRODUCTS

2.1 DESIGN PERFORMANCE

A. Structural Performance of Handrails: Design, test, fabricate, and install handrails to meet applicable codes and OSHA requirements without exceeding the allowable design working stress or allowable deflection.

2.2 ORNAMENTAL ALUMINUM HANDRAILS

A. General:

1. Furnish pre-engineered and prefabricated handrails.
2. Pop rivets and glued railing construction not permitted.

B. Manufacturers and Products:

1. Livers Bronze Co.; Struct-U-Rail System.

C. Rails, Posts, and Components:

1. Base: Model no. 810A extruded aluminum base, 2-½" x 4".
2. Cap Rail: 2-½-inch diameter aluminum, clear anodized.
3. Glass Panels: ½-inch tempered glass panels.
4. Side Mounted HANDRAIL: 1 ½-inch diameter aluminum handrail with Model no. RB1053 bracket, clear anodized.
5. Landing Rail Panel Insert: Model no. RI 2001.
6. Stringer Rail Panel Insert: Model no. RI 2001 DP.
7. Provide all components and accessories required for complete assembly and installation per manufacturer requirements, including wall brackets, anchors and fasteners, and steel inserts required for structural support and anchorage.

2.3 ALUMINUM HANDRAILS

A. General:

1. Furnish pre-engineered and prefabricated two handrails.
2. Pop rivets and glued railing construction not permitted.

B. Manufacturers:

1. Thompson Fabricating Co., Birmingham, AL.
2. Moultrie Manufacturing, Moultrie, GA; Wesrail II.

C. Rails, Posts, and Formed Elbows: Extruded Alloy 6105-T5 or 6061-T6, minimum tensile strength of 38,000 psi and minimum yield strength of 35,000 psi.

1. Miscellaneous Aluminum Parts: 6063-T6 or 6061-T6 extruded aluminum of adequate strength for all loads.
2. Post and Railing: Nominal 1-1/2-inch diameter.
   a. Rails: 1.900-inch outside diameter by 0.145-inch wall thickness, Schedule 40.

b. Posts: 1.900-inch outside diameter by 0.200-inch wall thickness, Schedule 80.
c. Solid dowel interconnectors of 6105-T5 or 6061-T6 aluminum.

D. Fittings:

1. Top Mount Post Base:
   a. Cast aluminum.
   b. Four holes in base for concrete anchors. For narrow walls or curbs, furnish two holes in base for concrete anchors with required edge distance.
   c. Manufacturer and Products: Thompson Fabricating Co.; Part No. TBF-3.4 and Part No. TBF-3.2 for narrow walls and curbs.
2. Handrail and Post Fittings: Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements. Fittings shall match color of pipe in handrails. Sand cast parts not permitted.
3. Side Mounted Handrail Bracket: Extruded aluminum, Alloy 6063-T6 with four holes for bolts or concrete anchors.
   a. Manufacturer and Product: Thompson Fabricating Co.; Part No. TSM-1.5.
4. Concrete Anchors for Securing Bases and Brackets to Concrete: Type 304 or 316 stainless steel ½-inch concrete anchors.
5. Handrail Connections for Metal Stairway Stringers:
   a. Extruded aluminum bracket, Alloy 6063-T6.
   b. Brackets bolts ½-inch diameter Type 304 or 316 stainless steel bolts.
   c. Offset adjustable stair fitting of cast Al-mag, Part No. ASF.
   d. Manufacturer and Products: Thompson Fabricating Co.; Part Nos. SMB-2 or SMB-3, ASF, APF.
6. Handrail Connections for Metal Beams:
   a. Extruded aluminum bracket, Alloy 6063-T6.
   b. Bracket bolts ½-inch diameter Type 304 stainless steel bolts.
   c. Manufacturer and Products: Thompson Fabricating Co.; Part Nos. SMB-2 or SMB-3. Use Part No. TSM-1.5 if bracket is attached to flat side of a channel.
7. Handrail Wall Brackets: Cast Al-mag aluminum bracket, Part No. AWF adjustable wall fitting, with provision for three 3/8-inch Type 304 stainless steel bolts or concrete anchors.
   a. Manufacturer and Product: Thompson Fabricating Co.; Part No. AWF.
8. Miscellaneous Rail to Post Fittings:
   a. Cast Aluminum Tee Fittings: Part Nos. TF-1 and TX-1.
   b. Cast Aluminum Ell Fittings: Part Nos. TE-1, TE-2, and TE-3.
   c. Aluminum Splice Lock: Part No. SL-1.

d. Aluminum Expansion Joint Splice: Part No. ES-1.
e. Formed Aluminum Wall Flange: Part No. CF-2.
f. Manufacturer: Thompson Fabricating Co.

9. Toeboards and Accessories:
   a. Material: Molded or extruded 6063 or 6061 aluminum.
   b. Manufacturer: Thompson Fabricating Co.
10. Castings for Handrails: Cast Al-mag with sufficient strength to meet load and test requirements. Anodizable grade finish with excellent resistance to corrosion when subject to exposure of sodium chloride solution intermittent spray and emersion.

E. Concrete Embedded Metal Anchorages: In accordance with Section 05500, METAL FABRICATIONS AND CASTINGS.

F. Finishes:

1. Handrail Pipe and Post: In accordance with AA 45, designation AA-M32-C22-A41, clear anodized.
2. Cast Fittings and Toeboards: In accordance with AA 45, designation AA-M10-C22-A41, clear anodized.

2.4 FABRICATION OF ALUMINUM HANDRAILS

A. Shop Assembly:

1. Post Spacing: Maximum 6-foot horizontal spacing.
2. Aluminum handrails free of burrs, nicks, and sharp edges when fabrication is complete. Welding is not permitted.

B. Shop/Factory Finishing: Use same alloy for uniform appearance throughout fabrication for railings.

1. Handrail and Post Fittings: Match the fittings with the color of pipe in handrail. Sand cast parts not permitted. Provide matching end closure at exposed edges. Ends of wall mounted railings shall return to wall. Ends of floor-mounted railings shall not extend beyond other components.

C. Tolerances:

1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

PART 3 EXECUTION

3.1 GENERAL

A. Provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on the actual structure. Install railing with a base that provides plus or minus 1/4-inch vertical adjustment inside the base fitting. If adjustment is required in the field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

B. Field fabrication of aluminum railing systems not permitted.

C. Modification to structure not permitted where handrail is attached.

3.2 HANDRAIL INSTALLATION

A. Assembly and Installation: Perform in accordance with manufacturer's written recommendations for installation.

B. Rails:

1. Set rails horizontal or parallel to steps to within 1/8-inch in 12 feet.
2. Install rails in same plane. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.

C. Handrail Wall Brackets: Support wall rails on brackets spaced maximum 6 feet on centers for steel and 5 feet for aluminum as measured on the horizontal projection.

3.3 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

C. If stain remains after washing, restore in accordance with manufacturer's recommendations, or replace stained handrails.

END OF SECTION

SECTION 06000
CARPENTRY

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Plywood Association (APA): Grades and Specifications.
2. American Society for Testing and Materials (ASTM): A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
3. American Wood Preservers' Association (AWPA): C2, Lumber, Timbers, Bridge Ties and Mine Ties-Preservative Treatment by Pressure Processes.
4. American Wood Preservers Bureau (AWPB): LP-2, Water Borne Preservatives (Above Ground).
5. Architectural Woodwork Institute (AWI): Quality Standards, Guide Specifications and Quality Certification Program.
6. Product Standards (PS)-U.S. Department of Commerce National Bureau of Standards:
   a. 1, For Construction and Industrial Plywood.
   b. 20, American Softwood Lumber Standard.
7. Western Wood Products Association (WWPA): Standard Grading Rules for Western Lumber.

1.2 SUBMITTALS

A. Shop Drawings:

1. Window Sills:
   a. Show field measurements, construction details, dimensions, materials, and finish.
   b. Use full-size or 1/4-scale drawings.
   c. Key Shop Drawings to Contract Document Drawings.
   d. Samples for color selection.

1.3 QUALITY ASSURANCE

A. Lumber Grades and Wood Species: U.S. Product Standard PS 20 and the National Forest Products Association.

1. Wood Members: Requirements above and in “Design Values for Wood Construction”, supplement to the 1977 edition of National Design

Specification for Wood Construction, published by National Forests Products Association.

2. Identify each piece or bundle of lumber or other product with a recognized mark of the authority grading the product.

B. Plywood Grades: U.S. Product Standard PS 1. Identify each plywood panel with appropriate grade trademark of American Plywood Association.

C. Finish Carpentry: Quality Standards of Architectural Woodwork Institute (AWI) unless detailed otherwise.

D. Preservative and Pressure Treated Material: American Wood Preservers Association Standards (AWPA) and bear the American Wood Preservers Bureau (AWPB) quality mark designation.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Place materials in dry storage areas immediately upon delivery and maintain relative humidity at 60 percent or less.

B. Store materials 6 inches minimum aboveground on framework or blocking; cover with protective waterproof covering and provide adequate air circulation or ventilation.

C. Do not store seasoned materials in wet or damp portions of building.

D. Do not subject to extreme changes of temperature or humidity.

E. Protect fire-retardant materials against high humidity and moisture during storage and erection.

F. Protect sheet materials from corner breaks and surface damage while unloading.

PART 2 PRODUCTS

2.1 LUMBER

A. Framing Lumber: Dimensions given are nominal; surface four sides (S4S); moisture content not over 19 percent, unless specified otherwise; provide as follows:

Usage	Minimum Grade
General framing, studs, plates, blocking, furring, braces, & nailers	Standard & Better or Stud Grade

B. Finish Lumber: Kiln-dried; average moisture content range as follows: 9 to 12 percent.

2.2 PLYWOOD

A. Softwood Plywood: APA A-B Interior.

2.3 PRESERVATIVE TREATED WOOD

A. Material: Waterborne salt preservatives; AWPA C2 and AWPB LP-2. Furnish sufficient amount for onsite application to sawed or cut surfaces.

2.4 PLASTIC LAMINATE WINDOW SILLS

A. Meet the requirements of AWI Quality Standards Section 400 for laminate clad cabinets.

B. Furnish window sill exposed surfaces, including top, edges and front face with plastic laminate.

2.5 ANCILLARY MATERIALS

A. Adhesives:

1. For Woodwork: Phenol-resin or resorcinol-resin.
2. For Plastic Laminate: Contact cement, Federal Specification MMM-A-130B.

B. Fasteners:

1. Nails: Steel common nails for framing, sizes as shown; hot-dipped zinc-coated nails where exposed; deformed shank nails for fastening underlayment.
2. Bolts and Screws: ASTM A307, galvanized where exposed.
3. Framing Anchors: Simpson, Teco, or Bowman galvanized 18 gauge steel, complete with nails recommended by manufacturer.
4. Provide fasteners and miscellaneous hardware required for assembling and anchoring finish woodwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces to receive carpentry items are prepared.

3.2 PREPARATION

A. Do not install finish interior woodwork until the building has been dried for at least 10 days.

3.3 ROUGH CARPENTRY ERECTION

A. Preservative Treated Wood:

1. Use for framing, blocking, furring, nailing strips built into exterior masonry walls, wood in contact with concrete and in conjunction with built-up roofing.
2. Apply two brush coats of same preservative used in original treatment to all sawed or cut surfaces of treated lumber.

B. Blocking: Locate blocking to facilitate installation of finishing materials, fixtures, specialty items, hardware, and trim.

3.4 FINISH CARPENTRY INSTALLATION

A. General:

1. Lay out, cut, fit, and install finish carpentry items.
2. Anchor to ensure rigidity, tight fit, and permanence, and as shown.
3. Install items accurate to dimension, true to line, level, and square unless otherwise shown.
4. Follow manufacturer's instructions for installation of hardware and other items.
   a. Make Work neat and secure, developing full strength of components and providing intended function.

END OF SECTION

SECTION 07210
BUILDING INSULATION

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. C516, Standard Specification for Vermiculite Loose Fill Thermal Insulation.
   b. C549, Standard Specification for Perlite Loose Fill Insulation.
   c. C578, Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation.
   d. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   e. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.2 DELIVERY, STORAGE, AND HANDLING

A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.

B. Store materials off ground and keep them dry at all times. Protect against weather, condensation, and damage.

PART 2 PRODUCTS

2.1 BATT INSULATION AND FASTENERS

A. Fiberglass or Mineral Wool Batts:

1. Sound Attenuation Blankets: ASTM C665, Type I, 3-1/2 and 2-inch thick; see Drawings.
2. Manufacturers:
   a. Certainteed.
   b. Owens-Corning Fiberglas Corp.
   c. Johns Manville.

B. Fasteners: As recommended by insulation manufacturer.

2.2 RIGID INSULATION

A. Extruded polystyrene foam.

B. ASTM C578, Type IV.

C. Flame Spread: Less than 25 when tested per ASTM E84.

D. Thickness: 2 inches with a R-value of R=10, minimum.

E. Manufacturers and Products:

1. Dow Chemical Co.; Square Edge.
2. UC Industries; Foamular.

2.3 NAIL BASE ROOF INSULATION

A. Polyisocyanurate Foam Core:

1. Faced on upper side with 7/16-inch oriented strand board (OSB) and on reverse side with foil or asphalt-coated fiberglass.
2. Thickness: 4 inches with a R-value of R=27, minimum.
3. Manufacturers and Products:
   a. Atlas Roofing Corp.; AC Foam Nail Base Insulation.
   b. Celotex; Hy-Therm Nail-Line Roof Insulation.
   c. RMAX, Inc.; Nailable Base Insulation.

PART 3 EXECUTION

3.1 BATT INSULATION

A. Install in accordance with manufacturer's instructions and as specified below:

1. Install faced batt insulation, in widths required by framing spacing, with vapor retarder facing warm side.
2. Fit tightly to ensure continuous seal. Tape overlapping flanges of vapor retarder when necessary, using tape as recommended by insulation manufacturer.
3. Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on cold weather side of obstruction.
4. Protect installed insulation from tears and other damage until covered with finish material.
5. Remove and replace damaged material.

3.2 RIGID INSULATION

A. Install boards in location and in thicknesses as specified and as shown.

B. Cut insulation with saw, knife, or other sharp tool to fit tightly around obstructions.

C. Butt insulation boards together tightly at joints.

D. Apply to masonry or concrete with nails or fasteners recommended by insulation manufacturer.

3.3 NAIL BASE ROOF INSULATION

A. Install in accordance with manufacturer's recommendations, and as specified below:

1. Place insulation boards, sized as large as practical, with oriented strand board side up, long dimension parallel to eaves, and end joints staggered.
2. Use nails or mechanical fasteners as recommended by insulation manufacturer.
3. Install wood nailing strips equal to thickness of insulation board along eaves and rake edges.

END OF SECTION

SECTION 07260
VAPOR RETARDERS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. D828, Standard Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus.
   b. E96, Standard Test Methods for Water Vapor Transmission of Materials.

1.2 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's materials' specifications.
2. Manufacturer's written instructions for preparation, installation/application, repair, protection and maintenance.

B. Quality Control Submittals: Manufacturer's certification of product compliance.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store fluid-applied materials in area where temperatures are not less than 50 degrees F or over 85 degrees F, unless otherwise authorized in writing by manufacturer.

PART 2 PRODUCTS

2.1 UNDERSLAB VAPOR RETARDER

A. High-strength Kraft paper, laminated with bi-directional glass reinforcing fibers, with polyethylene coating on both surfaces:

1. Weight: 4.2 pounds per 100 square feet.
2. Permeability Value: 0.10 in accordance with ASTM E96, Procedure A.
3. Water Resistance: 76 hours minimum in accordance with ASTM D779.
4. Dry Tensile Strength (Pounds per 1-inch Width): MD 75 and CMD 35.
5. Wet Tensile Strength (psi): MD 5,000 psi and CMD 2,800 psi in accordance with ASTM D828.
6. Puncture Resistance: 120 beach units.

B. Manufacturers and Products:

1. Fortifiber Corp.; Moistop Underslab.
2. Reef Industries, Inc.; Griffolyn-65G.

2.2 FLUID APPLIED VAPOR RETARDER

A. Two-Component Butyl Rubber Elastomer:

1. Brush or spray consistency.
2. Manufacturer and Product: Futura Coatings, Inc.; Elasto-Bond 801.

2.3 ANCILLARY MATERIALS

A. Sand:

1. Natural or clean; free from clay, organics, or other materials that would damage vapor retarder.
2. Gradation:
   a. Produced from maximum size 1/4-inch crushed gravel or crushed rock.
   b. 95 percent passing No. 4 sieve, with maximum of 5 percent passing No. 200 sieve.
   c. Maximum Grain Size: 3/16-inch.
3. Do not use saltwater sources or beach sand.

B. Fasteners, Tape, Adhesive, or Sealant: As recommended by vapor retarder manufacturer.

PART 3 EXECUTION

3.1 UNDERSLAB VAPOR RETARDER

A. Installation:

1. Apply vapor retarder in accordance with manufacturer's instructions, except as follows:
   a. After base for slab has been leveled and tamped, apply vapor retarder with roll width parallel to direction of pour.
2. Joints:
   a. Minimum Lap: 6 inches.
   b. Seal with tape or adhesive as recommended by vapor retarder manufacturer.

B. Repairs:

1. Tear or Holes Under 6 Inches in Length: Repair with tape.
2. Tear or Holes Over 6 Inches in Length: Replace entire sheet.

C. Sand Cover:

1. Cover vapor retarder with 2-inch layer of sand with top surface at elevation of bottom of slab.
2. Moisten sand and thoroughly and compact with a vibratory plate compactor.

3.2 FLUID APPLIED VAPOR RETARDER

A. Examination: Verify that appropriate substrate and environmental conditions exist prior to starting Work.

B. Preparation:

1. Clean surfaces, in accordance with manufacturer's written instructions, of dust, dirt, oil, wax, and other foreign materials.
2. Remove efflorescence by scrubbing surface with muriatic acid and thoroughly rinsing with water.
3. Fill cracks, voids, and honeycombs with mortar to provide sound surface.
4. Allow 72 hours surface drying time before applying vapor retarder.

C. Application:

1. Do not apply when ambient temperature is less than 50 degrees F, or when temperatures below 40 degrees F are predicted within 24 hours after application.
2. Do not apply in rainy conditions or within 72 hours after surfaces become wet from rainfall or other moisture.
3. Use brush or approved low-pressure airless spray equipment with coarse nozzle.
4. Rate: In accordance with manufacturer's written recommendations.
5. Commence application at top of wall and work down surface, keeping a wet edge at all times, forming a continuous unbroken film, free from pinholes and other surface breaks.
6. Film Thickness: As required to provide perm rating not greater than 0.1.
7. Protect surfaces from heat and direct sunlight until dried.

D. Testing:

1. After vapor retarder has dried, spray surfaces with water.
2. Recoat surfaces that show water absorption.

3.3 CLEANING

A. Upon completion of vapor retarder installation, remove waste materials and debris resulting from this operation and dispose offsite.

B. Clean fluid applied spillage and overspray from adjacent surfaces as recommended by manufacturer.

END OF SECTION

SECTION 07610
SHEET METAL ROOFING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   b. A792/A792M, Standard Specification for Steel Sheet, Aluminum-Zinc Alloy-Coated by the Hot-Dip Process, General Requirements.
   c. B32, Standard Specification for Solder Metal.
   d. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   e. D226, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   f. D2178, Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
2. Federal Specifications (FS): O-F-506C, Flux, Soldering; Paste and Liquid.
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Architectural Sheet Metal Manual, 5th Ed..

1.2 SUBMITTALS

A. Shop Drawings:

1. Drawings showing thickness and dimensions of all parts, fastening and anchoring methods, details, and locations of all seams, joints, and other provisions for thermal movement. Include Drawings at not less than 1/4-inch to 1-foot scale and details at not less than 3-inch to 1-foot scale.
2. Two copies of manufacturer's printed installation instructions.

B. Quality Control Submittals: A letter from the roofing manufacturer stating that the roofer is approved by manufacturer to apply the roof.

C. Contract Closeout Submittals: Special guarantee.

1.3 QUALITY ASSURANCE

A. Applicator's Qualifications: Approved by the accepted system manufacturer. Roofer shall be regularly engaged in construction of quality metal roofs, having successfully provided work similar to the type indicated on previous completed projects. Installer shall be specialized in sheet metal roof installations with 5 years documented experience.

B. Wind Uplift Resistance Classification: Roof assembly shall be classified as Class UL90 as defined by UL580 Specifications.

C. Static Air Infiltration: Completed roof system shall have a maximum of 0.06 CFM/Square Foot, with 6.24 PSF air pressure differential per ASTM 283.

D. Water Infiltration: No evidence of water penetration at an inward static air pressure differential of not less than 6.24 PSF and not more than 12.00 SF per ASTM E331.

E. Preroofing Conference:

1. Conduct preroofing conference with COTR/CM, roofing applicator, roofing system materials manufacturer, and subcontractors likely to be on the roof, present.
2. Discussion: To resolve questions regarding acceptability of the deck, roofing system and materials, flashing details, roof insulation, roof-mounted mechanical equipment, and roofing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Product Delivery: Keep panels dry.

B. Product Storage and Handling:

1. Protect against damage and discoloration.
2. Handle panels with nonmarring slings.
3. Do not bend panels.
4. Store panels aboveground, with one end elevated for drainage.
5. Stack panels to prevent twisting, bending, or abrasion, and to provide ventilation.
6. Protect panels against standing water and condensation between adjacent surfaces.
7. If panels become wet, immediately separate sheets, wipe dry with clean cloth, and separate sheets for air-drying.
8. During storage prevent contact with materials that may cause discoloration or staining.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Apply roofing only in dry weather and when ambient temperature is above 40 degrees F.

1.6 SPECIAL GUARANTEE

A. Product: Provide manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of the OWNER, removal and replacement of roofing panels, flashing, finish, and accessories found defective during a period of 20 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified the General Conditions.

B. Conditions:

1. Roofing Panels: No rupture, structural failure, or perforation.
2. Finish: No cracking, blistering, flaking, chipping, checking, chalking, peeling, or fading.
3. Components: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.1 ROOFING PANELS

A. Material: Steel, galvanized, ASTM A653/A653M, coating designation G90, or ASTM A792/A792M coated steel, 24-gauge minimum metal thickness.

B. Finish:

1. Polyvinylidene Fluoride: Kynar 500, two coats minimum.
2. Color: Dark bronze.

C. Batten Seam:

1. Flat panels with upturned or overtapped edges that are covered with a square profile snap-on cover to form the joints or seams.
2. Interlocking panels without separate joint covers are not acceptable.
3. Manufacturer and Product: Berridge; Batten Seam.

2.2 ACCESSORY MATERIALS

A. Ice and Watershield Membrane: 40-mil rubberized asphalt and polyethylene as manufactured by W.R. Grace and Co.

B. Slip Sheet: Rosin-sized building paper, minimum 6 pounds per square or 0.050-inch Manniglas Slipsheet manufactured by Lydall, Inc., Manning Division, Troy, NY, installed on top of ice and watershield membrane.

C. Fasteners:

1. Stainless steel or alloy appropriate to the particular metal specified for roofing.
2. Screws: Panhead wood or sheet metal type.
3. Exposed Fasteners: Finished to match roofing.

D. Holddown Clips: System manufacturer's ASTM A792/A792M standard shape steel.

E. Solder: ASTM B32, Class A, Grade 1, composition 50/50 tin/lead.

F. Soldering Flux: Federal Specification O-F-506, Type 1, Form A or B.

G. Closures: Manufacturer's standard neoprene blocks shaped to fit roof metal profile.

H. Sealant: Type 6 as specified in Section 07900, JOINT SEALANTS.

2.3 FABRICATION

A. Configuration: Form panels for batten seams spaced 16 inches on center.

B. Edges: Turned up 7/8-inch high minimum.

C. Panel Length: As long as practical, preferably from eave to ridge.

D. Fabricate flashings and trim from same metal as roof panels.

E. Form and fabricate sheets, battens, strips, cleats, valleys, ridges, edge treatments, integral flashings, gutters, downspouts, and other components of specified metal roofing panels to profiles, patterns, and drainage arrangement shown, and as required for permanent leakproof construction in accordance with SMACNA Sheet Metal Manual.

F. Pipe Penetrations Through Roof: Roofing manufacturer’s standard pipe seal set in sealant and sealed around top.

G. Provide for thermal expansion and contraction of Work.

PART 3 EXECUTION

3.1 SHEET METAL ROOFING SYSTEM

A. Install metal roofing system consisting of nonstructural sheet metal panels held to substrate with concealed fasteners.

B. Provide ridges, hips, valleys, eaves, rakes, fascia, coping, gutters, downspouts, and other exposed trim and flashings for a weathertight roofing system.

3.2 PREPARATION

A. Deck: Firm, dry, free of foreign materials, and smooth. Report immediately to the COTR/CM all cracks, breaks, holes, or other unusual irregularities in the surface.

B. Layout Pattern:

1. Lay out to place seams equidistant from corners and aligned with seams on other side of hip or ridge.
2. Coordinate Work of this section with flashing, trim, and other construction to provide a permanently leakproof, secure, and noncorroding installation.

3.3 INSTALLATION

A. General:

1. Comply with recommendations and instructions of metal roofing panel producer and SMACNA Sheet Metal Manual.
2. Conceal fasteners and expansion joint provisions wherever possible in exposed Work; locate so as to minimize the possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
3. Separate dissimilar metals from each other where electrolysis might occur. Separation is satisfactorily accomplished by coating the metal(s) with a 15-mil bituminous coating. Comply with various metals producers' recommendations for other forms of protection against contamination from corrosive materials or agents.

B. Install insulation per Section 07210, BUILDING INSULATION. Do not install more insulation than can be covered by roofing same day.

C. Ice and Watershield Membrane and Slip Sheet:

1. Remove release paper and install membrane horizontally beginning at eaves. Lap fascia 2 inches. Provide 6-inch end laps and 3-1/2-inch side laps. Continue membrane up roof to cover entire roof field. Center full width sheet over ridge.
2. Cover with loose-laid slip sheet similarly lapped and with joints staggered.
3. Install no more than can be covered by metal roofing, or other approved protection, in same day.

D. Roofing Panels:

1. Begin at eaves.
2. Locate holddown clips in joints within 6 inches of panel ends and at 18 inches on center, maximum.
3. At eaves cut upturned edges and bend panel down to form fascia.
4. At intersections of roof slope with ridge and hips, turn up edges of roof panels 1 inch.

E. Cross Seams: Not allowed on interlocking panels.

F. Seam or Joint Covers:

1. Snap in-place over clips and upturned edges of roof panels.
2. At eaves cut sides of covers and fold down over fascia in one continuous piece.

G. Valleys:

1. Form of sheets not exceeding 10 feet in length. Lap joints 6 inches in direction of drainage.
2. Extend valley sheet minimum 6 inches under roofing sheets.
3. At valley, double fold valley and roofing sheets and secure with cleats spaced 18 inches on center.

H. Edges:

1. Extend gutter lining under metal roofing 6 inches minimum and terminate in 3/4-inch folded edge secured by cleats.
2. Hook lower end of roofing into lock strip to form 3/4-inch wide loose-lock seam.

I. Ridge and Hip Covers: Secure in-place using Z-closer clips and fasteners. Seal joints where necessary for weathertightness.

J. Metal Roofing, Gutters, Downspouts, and Flashings: Straight, weathertight, exposed surfaces free of dents, scratches, abrasions, stains, and other visible defects.

K. Cutting and Fitting: Neat, square, and true. Saw cut panels, deburr, and use touchup paint immediately as recommended by roofing panel manufacturer. Torch cutting is prohibited.

3.4 CLEANING AND PROTECTION

A. Cleaning:

1. At the end of each day sweep metal clean of foreign materials, especially metal particles and scrap.
2. Peel off all strippable film.

B. Protection:

1. Protect material from exposure to chlorides, hydrochloric-based and muriatic acids. If contaminated, wash affected areas immediately with 5 percent soda and water solution and rinse with clear water.
2. Avoid walking on roof after completion.

C. Final Cleanup:

1. Remove all debris, metal clips, nails, and other materials that could prevent adequate drainage or produce corrosion products through electrolysis.
2. Repair and touch up damage.

END OF SECTION

SECTION 07840
FIRESTOPPING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Society for Testing and Materials (ASTM):
   a. E814, Test Method for Fire Tests of Through-Penetration Firestops.
2. Underwriters Laboratory, Inc. (UL):
   a. 1479, Fire Tests of Through-Penetration Firestops.
   b. 2079, Tests for Fire Resistance of Building Joint Systems.

1.2 SYSTEM DESCRIPTION

A. Provide systems of material or combination of materials used to fill openings around penetrating items to prevent the spread of fire and retain integrity of fire rated construction by maintaining an effective barrier against spread of flame, smoke, water, and hot gases through penetrations in fire rated wall and floor assemblies.

B. Provide Fire Safing:

1. At slot gaps between edge of floor slabs and exterior walls.
2. Gaps between top of walls and structure above.
3. Expansion joints in walls, floors, and ceilings.
4. At penetrations in fire-rated assemblies.

C. Performance Requirements: Provide firestop systems with materials that have been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

D. Regulatory Requirements:

1. Firestop Systems: Meet requirements of ASTM E814, UL 1479, or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.
2. Proposed Firestop Materials and Methods: Conform to applicable governing codes having local jurisdiction.

3. Meet F and T ratings of ASTM E814 for a period equal to construction penetrated.
4. Underwriters Laboratories classified as fill, void, or cavity materials under UL 1479.

1.3 SUBMITTALS

A. Product Data: Submit product data including manufacturer's SPEC-DATA® product sheet for products selected for use.

B. Shop Drawings: Submit shop drawings showing layout, profiles, and product components. Include UL Systems Number on shop drawings and diagram of UL approved assembly.

C. Quality Assurance Submittals:

1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
2. Certificates:
   a. Product certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical requirements.
   b. Certificate indicating installer qualifications.
   c. Certificate of Proper Installation.
3. Manufacturer's Instructions: Manufacturer's installation instructions.

D. Contract Closeout Submittals: Special Guarantee documents specified below.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Experienced in performing work of this Section and specialized in the installation of work similar to that required for this Project.

B. Pre-Installation Meetings: Conduct pre-installation meeting to identify where seals are required and verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at Project site.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification and UL labels intact.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.

D. Follow recommended procedures, precautions, or remedies described in Material Safety Data Sheets as applicable.

1.6 SEQUENCING AND SCHEDULING

A. Firestopping requirements may be created by mechanical and electrical portions of the Work:

1. Identify locations requiring firestopping.
2. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

PART 2 PRODUCTS

2.1 GENERAL

A. Furnish firestop system products from a single manufacturer.

2.2 MANUFACTURERS

A. 3M Corp.; Firestopping Products.

B. Hilti Construction Chemicals; High Performance Firestop Systems.

C. International Protective Coatings Corp. (IPC); Flamesafe Firestop Products.

D. Isolatek International (Cafco); TPS.

E. Specified Technologies; Inc. (STI).

F. United States Gypsum Co. (USG); Firestop Systems and Thermafiber Safing Insulation.

2.3 MIXES

A. For those products requiring mixing prior to application, follow firestopping manufacturer’s directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce firestopping products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. With manufacturer's representative, examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean openings and joints immediately prior to installing firestopping in accordance with firestop manufacturer recommendations and the following requirements:

1. Remove foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form release agents from concrete.

B. Priming: Prime substrates where recommended by firestopping 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 firestopping from contacting adjoining surfaces that will remain exposed upon completion of work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing firestopping seal with substrates.

3.3 INSTALLATION

A. Manufacturer's Instructions: Follow manufacturer's instructions for installation of through-penetration systems selected for use.

1. Seal holes or voids made by penetrations for pipes, conduits and ducts through fire-rated floors, walls, and roofs and to ensure air and water resistant seals.
2. Receive COTR/CM's approval prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

B. Fire Safing: Install, following manufacturer's instructions, to completely fill gaps between tops of fire-rated walls and floor or roof deck above, between edge of floors and walls, and other locations indicated on Drawings.

C. Meet Underwriters Laboratories and Factory Mutual requirements.

3.4 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform patching and repairing of firestopping caused by cutting or penetrating existing firestop systems.

3.5 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01640, MANUFACTURERS' SERVICES, for installation assistance, inspection and certification of proper installation, and training of Installer's personnel in proper installation procedures.

3.6 PROTECTION

A. Protect installed product from contact with contaminating substances and from damage during construction.

END OF SECTION

SECTION 07900
JOINT SEALANTS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. C920, Standard Specification for Elastomeric Joint Sealants.
   b. C962, Standard Guide for Use of Elastomeric Joint Sealants.

1.2 SUBMITTALS

A. Manufacturer's Literature.

B. Application Instructions.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Ambient Temperature: Between 40 and 80 degrees F when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sealant Type 4: Multipart polyurethane; ASTM C920, Type M, Grade NS, Class 25; Sonolastic NP-II, Pecora Dynatrol II, or Tremco Dymeric.

B. Sealant Type 6: One-part polyurethane; ASTM C920, Type S, Grade NS, Class 25; Sonolastic NP-I, Pecora Dynatrol I, or Tremco Dymonic.

C. Sealant Type 9: One-part acrylic; Tremco Mono, Pecora 60+ Unicrylic, or PTI 738.

D. Sealant Type 10: Silicone; Dow Corning 786, or General Electric Sanitary Sealant.

E. Sealant Type 11: Dow Corning Corp., Fire Stop Sealant or Foam; 3M Corp., Fire Barrier Caulk CP25 and Putty 303; General Electric, Pensil Sealant or Foam.

F. Backup Rod: Nongassing, extruded, closed-cell, round polyethylene foam rod.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify conditions are acceptable for sealants; clean, dry, sound, and free of dust and other foreign matter.

B. Mask adjacent surfaces.

3.2 INSTALLATION

A. Conform to ASTM C962.

B. Backup Rod: Install in joints wider than 3/16 inch.

C. Seal joints around windows, doors, and louver frames, and as indicated.

D. Apply materials in accordance with manufacturer's recommendations and instructions.

E. Fill joints completely from back to face, without voids.

F. Tool joints concave.

3.3 CLEANING

A. Clean smears and other soiling caused by sealant.

B. Replace or repair to OWNER's satisfaction damaged surfaces resulting from sealing or cleaning.

3.4 APPLICATION SCHEDULE

A. Type 4 or 6: Exterior joints.

B. Type 9: Interior joints.

C. Type 10: Around plumbing fixtures and between counter top and backsplash.

D. Type 11: Holes and voids around penetrations through fire rated elements.

END OF SECTION

SECTION 08100
METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): A115, Frames, a Collection.
2. American Society for Testing and Materials (ASTM):
   a. A366/A366M, Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.
   b. A525/A525M, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process.
   c. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
3. National Fire Protection Association (NFPA): 80, Standard for Fire Doors and Windows.
4. Steel Door Institute (SDI):
   a. 100, Recommended Specifications, Standard Steel Doors and Frames.
   b. 105, Recommended Erection Instructions for Steel Frames.
   c. 107, Hardware on Steel Doors.

1.2 SUBMITTALS

A. Shop Drawings: Applicable information for each type of door and frame, including:

1. Frame conditions and complete anchorage details, supplemented by suitable schedules covering doors and frames.
2. Glass and louver opening sizes and locations in doors.
3. Connections of door frames to structural steel framing concealed in frames.
4. Location and field splice joints for frames too large to ship in one piece; indicate complete instructions for making field splices.
5. Joints required to accommodate expansion joint movement.
6. Relate to door numbers used in Contract Drawings.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Properly identify each item with number used in Contract Drawings.

B. Store doors upright, in protected dry area, at least 1 inch off ground or floor and at least 1/4 inch between individual pieces.

PART 2 PRODUCTS

2.1 HOLLOW METAL UNITS

A. Manufacturers:

1. Curries Manufacturing.
2. The Ceco Corp.
3. Fenestra Division, Marmon Group.
4. Mesker Industries, Inc.
5. Monarch Steelcraft, Ltd.
6. Overly Manufacturing Co.
7. Pioneer Industries.
8. Precision Metals, Inc.
9. Republic Steel Corp.
10. Steelcraft Manufacturing Co.
11. Trussbilt, Inc.
12. Williamsburg Steel Products Co.
13. Stiles Custom Metal, Inc.

B. Basic Metal Material: ASTM A366; sheet steel, cold-rolled, stretcher level.

C. Hollow Metal Frames:

1. Products of hollow metal door manufacturer.
2. SDI 100, except as modified herein.
3. Frames for Doors and Windows: 14-gauge welded type, of cross-section shown.
4. Prepare floor and wall anchors, reinforcement, and cutouts for hardware to meet requirements of SDI 107.
5. Finished size, shape, and profile of frame members as shown.
6. Concealed fasteners or welding are preferred to through-the-face fasteners.
7. Identification: Stamp opening number, as shown on Drawings, on center hinge reinforcement of each frame.

D. Hollow Metal Doors: SDI 100, except as modified herein. SDI 107 and ANSI A115 to receive hardware specified in Door and Hardware Schedule.

1. Flush Panel Doors: 16-gauge, Grade III, Model 1, with polyurethane core.
2. Double Doors: Overlapping astragals for active leaf, except as noted or detailed otherwise.
   a. Flush end closure at top of doors.

E. Labeled Fire Doors and Frames:

1. Conform to listing requirements of Underwriters Laboratories (UL).
2. Label each door and frame for class of rating required.
3. Overlapping astragal on active leaf of double doors.
4. Label requirements, dimensions, and type of door are indicated in Door Schedule on Drawings.
   a. Modify drawing details if required to secure label.
   b. Clearly identify modifications on Shop Drawings.
   c. Maximum temperature rise of 450 degrees F for stairway enclosures.
5. Provide core as required for fire rating.

F. Sound-Retardant Doors and Frames: Treat flush metal doors internally to produce tested Sound Transmission Class (STC) of 40 decibels or better when tested in accordance with ASTM E90.

1. Glass, Louvers, and Sound Seals: Factory install.
2. Seals, Automatic Door Bottom Seals, and Astragals: Same as units tested and certified.
3. Provide sound-retardant doors and frames at all interior doors.

G. Glazing:

1. Doors: Furnish with formed flush-type glazing strips with butt corner joints to permit selection of secure side in field.
2. Glazing Arrangements: Accommodate glass of type and thickness indicated and as specified in Section 08800, GLAZING.

2.2 FACTORY FINISHING REQUIREMENTS

A. Hollow Metal Door and Frame Finish:

1. Galvanized with A60 or G60 zinc coating in accordance with ASTM A525 (Wipe Coat galvanized coating is not acceptable).

2. Phosphate treated for paint adhesion.
3. One shop coat of baked-on rust-inhibiting prime and finish coating as specified in Section 09900, PAINTING, System No. 107.

PART 3 EXECUTION

3.1 INSTALLATION

A. Frames:

1. Installation:
   a. Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.
   b. Secure anchorages and connections to adjacent construction.
   c. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.
2. Hollow Metal Frames: SDI 105.

B. Doors:

1. Hollow Metal Doors: SDI 100.
2. Hardware: In accordance with manufacturer's templates and instructions.
   a. Adjust operable parts for correct function.
   b. Remove hardware, with exception of prime coated items, tag, box, and reinstall after finish paint work is completed.
3. Labeled Doors: NFPA Pamphlet No. 80.

C. Provide manufacturer's standard core filler, anchors, fasteners, and other ancillary items.

3.2 FIELD PAINTING

A. Where prime coat has been damaged, sand smooth and touch up with same primer as applied at shop.

1. Remove rust before painting.
2. Touch Up: Not obvious.
3. Perform immediately after door and frame installation.

3.3 PROTECTION

A. Protect installed doors and frames against damage from other construction work.

3.4 SCHEDULES

A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see DOOR SCHEDULE on Drawings.

END OF SECTION

SECTION 08210
WOOD DOORS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society for Testing and Materials (ASTM): E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
2. Fir & Hemlock Door Association (FHDA): Industry Standard 7.
3. Wood Door Manufacturer's Association (WDMA):
   a. NWWDA Industry Standard IS 1, Architectural Wood Flush Doors.
   b. NWWDA Industry Standard IS 6, Wood Stile and Rail Doors.

1.2 SUBMITTALS

A. Shop Drawings: Prepare specifically for this Project, indicating location and size of each door, veneer species, type and characteristics, elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, factory finishing, if any, glass and glazing, and other pertinent data.

1. For factory-pre-machined doors, also indicate dimensions and locations of cutouts for finish hardware and cutouts for light and louver openings.
2. Use same reference numbers for door openings and details as Contract Drawings.

B. Quality Control Submittals:

1. Certification of compliance with reference standards.
2. Manufacturer's instructions for care and handling.
3. Maintenance instructions for sealing door edges.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver doors to jobsite after moisture-producing construction operations are complete and building has reached average prevailing relative humidity of locality.

2. Deliver doors clearly marked with manufacturer's name, brand name, size, thickness, and identifying symbol.
3. Seal edges of doors before delivery to jobsite.

B. Storage:

1. Store doors in area where there will be no variation greater than plus or minus 5 percent in heat and humidity.
2. Stack flat on 2 by 4 lumber, laid 12 inches from ends and across center.
3. Under bottom door and over top of stack provide plywood or corrugated cardboard to protect door surface.

C. Handling:

1. Handle with clean gloves.
2. Do not drag doors across one another or across other surfaces.

PART 2 PRODUCTS

2.1 FLUSH WOOD DOORS

A. Solid Core Wood Doors:

1. Premium grade, five-ply.
2. Framed block glued core or particle board core.
3. Type I glue.
4. Thickness: 1-3/4 inches.
5. Faces: Veneers and edge bands of quarter sliced red oak.

2.2 FABRICATION OF FLUSH WOOD DOORS

A. Manufacture: NWWDA Industry Standard IS 1, marked for conformance.

B. Molding and Glass Stop: Match edge band hardwood.

C. Pre-fitting and Pre-machining of Doors: At CONTRACTOR's option.

1. Within tolerances specified herein.
2. Coordinate with Finish Hardware Schedule and door frames.

2.3 SOUND-RESISTANT DOORS

A. Solid core doors with minimum Sound Transmission Class (STC) of 40 decibels or better when tested in accordance with ASTM E90.

B. Provide sound-resistant doors at all doors.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify door frames are of type required for door and are installed as required for proper installation of doors.

B. Do not install doors in frames that would hinder operation of doors.

3.2 INSTALLATION

A. Fit doors for width by planing; for height by sawing.

B. Tolerances:

1. From Bottom to Floor Covering: 1/2 inch.
2. From Bottom to Top of Threshold: 1/4 inch.
3. Maximum From Top: 1/8 inch.
4. Bevel Lock and Hinge Edges: 1/8 inch in 2 inches.
5. Clearance of Meeting Stiles of Pairs of Doors: 1/8 inch.

C. Seal jobsite cut surfaces with two coats of door manufacturer's standard sealer before final hanging of doors.

3.3 ADJUST AND CLEAN

A. Replace or re-hang doors that are hinge-bound and do not swing or operate freely.

B. Replace prefinished doors damaged during installation.

C. Refinish or replace job-finished doors damaged during installation.

3.4 SCHEDULE

A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see DOOR SCHEDULE on Drawings.

END OF SECTION

SECTION 08300
SPECIAL DOORS

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Manufacturer’s literature.
2. Shop drawings showing construction and installation details.

B. Quality Control Submittals:

1. Color Samples: Manufacturer's current color sample(s) for factory finishes.

1.2 QUALITY ASSURANCE

A. Qualifications: Experienced, factory authorized installer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors with separators and wrapping to protect units from damage during and after installation.

B. Store doors in protected dry area following manufacturer's requirements.

C. Handle doors according to manufacturer's instructions.

D. Protect exposed finish surfaces of prefinished items with wrapping.

PART 2 PRODUCTS

2.1 OPERABLE PARTITIONS

A. Manufacturers and Products:

1. Hufcor, Inc.; Spectrum Series 6953M.
2. Kwik-wall; All Steel Series 3040.
3. Panelfold, Miami, FL; Moduflex Series 800.
4. Modernfold, Inc., New Castle, IN; Acousti-Seal 932.

B. Manufactured Units: Continuously hinged, in pairs, center stacking, manually operated, top-supported, all-welded steel construction. Center two partition sections shall include 48-inch high by the panel width inset dry marker board on both sides of partition.

C. Acoustical Performance: Minimum STC 50 per ASTM 5-90 and E413, NRC.55.

D. Finishes: Class A, vertical ribbed acoustical wall fabric, 23 ounces per linear yard, adhered to steel face panels.

E. Hardware: Manufacturer's standard, including threaded rod supports, concealed track, suspension rollers, hinges, latch mechanism, and sound seals.

F. Trim: Manufacturer's standard jamb panel, jamb molding, and concealed track head molding.

2.2 ACCESS DOORS

A. Manufacturers:

1. Bar-Co, Enterprise, AL.
2. J.L. Industries, Bloomington, MN.
3. Karp Associates, Inc., Maspeth, NY.
4. Milcor Inc., Lima, OH.
5. J. R. Smith, Montgomery, AL.

B. Manufactured Unit(s): Flush panel access doors and frames with anchors to suit wall conditions. Recessed panel doors and frames with anchors to suit ceiling and wall conditions.

C. Size: Smallest standard size permitting ready access and removal of working parts, but not less than 12 inches square.

D. Door: 14-gauge minimum steel.

E. Frames:

1. Dry Wall Type: 16-gauge steel with outer flange in a dry wall bead configuration for application of joint compound.

F. Hinges: Spring-loaded concealed hinges permitting a minimum of 160-degree door travel and door removal.

G. Locks: Flush screw driver operated.

H. Finish: Section 09900, PAINTING, System No. 107.

PART 3 EXECUTION

3.1 OPERABLE PARTITION INSTALLATION

A. Level track and fasten securely to header as recommended by manufacturer.

B. Install partition in accordance with manufacturer's instructions.

C. Adjust and leave partition in smooth operating condition without any indication of binding.

3.2 ACCESS DOOR INSTALLATION

A. Install access panels at all cleanouts, valves, or other equipment requiring adjustment or servicing concealed within wall, furred spaces, or ceilings.

3.3 PRIME COAT TOUCHUP

A. Damaged Prime Coat:

1. Remove rust.
2. Sand smooth.
3. Use same primer as shop.
4. Touch up so it is not obvious.

3.4 PROTECTION

A. Protect installed doors against damage from other construction work.

3.5 SCHEDULE

A. For tabulation of door and frame characteristics, such as size, type and detail, see Drawings.

END OF SECTION

SECTION 08410
ALUMINUM ENTRANCES AND WINDOWS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
2. American Society for Testing and Materials (ASTM):
   a. C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
   b. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors under Specified Pressure Difference Across the Specimen.
   c. E330, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
   d. E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide a thermally isolated aluminum framing system that utilizes straight-in glazing without projecting stops. Position glass near exterior of frame and provide out-swinging operable vents where shown.
2. System shall have interior flashing to provide continuous flashing to exterior through pressure relieved horizontal weep holes.
3. Face Clip Design:
   a. Engaged by pushing straight into the clip.
   b. Easily removed for deglazing.
   c. Reusable for reglazing.
4. Entrances and glass framing shall be compatible in appearance.

B. Performance Requirements: Meet requirements of Article, PERFORMANCE TESTS.

1.3 SUBMITTALS

A. Shop Drawings:

1. Details of doors, windows, framing, and anchorage to structure.
2. Manufacturer's brochures or catalogs, specifications, recommendations, and standard details illustrating and specifying products proposed for use on this Project.
3. Show field measurements.

B. Quality Control Submittals:

1. Evidence of installer's qualifications.
2. Certified test reports showing compliance with specified performance tests.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Entity specializing in the installation of aluminum glazing systems, with a minimum of 3 years experience and approved by the system manufacturer.

B. Pre-Installation Meeting: Conduct to discuss and verify project requirements, substrate conditions, and manufacturer's installation instructions and warranty requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Store materials as recommended by manufacturer, in inside designated areas, free of dust and corrosive fumes, as close as possible to point of installation.

C. Prevent contaminants from contacting aluminum.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Framing systems, entrance doors, windows, and ventilators shall be the products of a single manufacturer.

B. Materials and products specified in this Section shall be products of: Kawneer Co., Model 45IT.

2.2 ALUMINUM ENTRANCES

A. Basic Aluminum Extrusions: 6063-T5 aluminum not less than 0.094-inch thick; door extrusions not less than 0.125-inch thick.

B. Framing Members: 4-1/2 inches in depth with thermal break and face width of 2 inches or less.

C. Swing Entrance Doors:

1. Thickness: 1-3/4-inches.
2. Stile and Rail Construction:
   a. Wide (over 4-inch).
   b. Mechanically fastened and welded.
   c. With square glass stops.
   d. Configuration indicated.

D. Glazing Gaskets: Framing manufacturer's standard EPDM elastomeric extrusion, conforming to ASTM C509.

E. Concealed Fastening Devices, Reinforcements, and Other Internal Components: of aluminum alloy, stainless steel, or corrosion-resistant plated.

F. Screws: Stainless steel, factory finished color to match the aluminum finish.

G. Hardware: As specified in Section 08710, DOOR HARDWARE.

2.3 WINDOWS

A. Materials and Framing: Same as Aluminum Entrances.

B. Ventilators:

1. Out-swing type with handle latch.
2. Hinges: Heavy duty 4-bar hinges with positive stop and an adjustable friction shoe.
3. Screens: Rigid metal frame screens to match window frames for all operable vents.

2.4 FINISH

A. Exposed Framing Members: Free of scratches and other serious surface blemishes.

B. Treatment and Color:

1. Caustic etch and anodic oxide.
2. Meet requirements of AA-M12C22A42.
3. Color: Dark bronze.

2.5 FABRICATION

A. Methods of Fabrication and Assembly: Manufacturer's discretion, unless otherwise specified.

B. Reinforcement for Surface Hardware: Manufacturer's standard.

C. Wind Load: Reinforce mullions as necessary to limit deflection to 1/175 of span when wind load on wall is 30 psf in addition to dead loads.

D. Assembly: As far as practicable, do fitting and assembly work in shop.

PART 3 EXECUTION

3.1 PREPARATION

A. Substrate Conditions: Verify acceptability for product installation in accordance with manufacturer’s instructions.

B. Field Measurements: Verify actual opening sizes prior to fabrication.

3.2 INSTALLATION

A. In accordance with manufacturer’s installation instructions.

B. Set items straight, level, square, plumb, and at proper elevations and in alignment with other work .

C. Securely anchor units to surrounding structure to resist wind loads and to withstand the normal loads imposed by the operation of the doors.

D. Fasten framing members in place using screws and backing, anchor plugs, or straps.

1. Accurately cut and fit framing and moldings to result in tightly closed flush, hairline weathertight joints.
2. No visible unfinished aluminum.
3. Provide concealed attachments and fasteners.

E. Door Operation:

1. Swing freely, and without rattle when closed.
2. Swing Type Doors: Head and jamb clearance of 3/32-inch, plus or minus 1/32-inch.

F. Seal all joints.

G. Glazing: As specified in Section 08800, GLAZING.

3.3 PERFORMANCE TESTS

A. Air Leakage Through Assembly: Maximum 0.06 cfm/minute/sq ft, as measured in accordance with ASTM E283.

B. Resistance to Water Infiltration: No leaks in the complete system when tested in accordance with ASTM E331 at a test pressure of 10.0 psf.

C. Performance Under Uniform Loading:

1. Test in accordance with ASTM E330 for a wind load of 30 psf.
2. Maximum Deflection: Not to exceed 1/175 of member span.
3. When Load is Removed: No permanent deformation or damage.

3.4 CLEANING

A. After erection, protect exposed portions from damage by machines, plaster, lime, paint, acid, cement, or other harmful compounds.

B. Remove protective materials and clean with plain water, water with soap, or household detergent.

3.5 PROTECTION

A. Protect adjacent areas and finish surfaces from damage during product installation.

3.6 SCHEDULES

A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see DOOR SCHEDULE on Drawings.

END OF SECTION

SECTION 08710
DOOR HARDWARE

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. A115.1, Preparation of Mortice Locks in 1-3/8-inch and 1-3/4-inch Standard Steel Doors and Frames.
   b. A117.1, Buildings and Facilities-Providing Accessibility and Usability for Physically Handicapped People.
   c. A156.1, Butts and Hinges (BHMA 101).
   d. A156.4, Door Controls-Closers (BHMA 301).
   e. A156.13, Mortise Locks and Latches (BHMA 621).
   f. A156.16, Auxiliary Hardware (BHMA 1201).
   g. A156.18, Materials and Finishes (BHMA 1301).

1.2 SUBMITTALS

A. Shop Drawings:

1. Product Data: Manufacturers' literature for each item of finish hardware required herein, clearly marked.
2. Finish Hardware Schedule: Furnish complete and detailed schedule, show product items, numbers, and finishes for all hardware for each separate opening.
3. Special Tools: Provide listing and description of usage.

B. Quality Control Submittals:

1. Operations and Maintenance Manual.
2. Manufacturer's Field Service Report.
3. Certification of Hardware Consultant.
4. Manufacturer's Certificate of Proper Installation.

1.3 QUALITY ASSURANCE

A. Qualifications of Supplier: A recognized supplier of architectural finish hardware, with warehousing facilities, who has been furnishing hardware in the vicinity of the Project for not less than 5 years, and who is, or who employs, an architectural hardware consultant.

B. Qualifications of Architectural Hardware Consultant (AHC): Certified by the Door and Hardware Institute.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide secure storage for all finish hardware until installation is made.

B. Before delivery, clearly identify and tag each item of hardware with respect to specified description and location of installation.

1.5 SPECIAL TOOLS

A. Two sets of special tools for installation and maintenance of hardware.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide end products of one manufacturer for each product in order to achieve standardization for appearance, maintenance, and replacement.

B. Finishes: ANSI A156.18.

2.2 FASTENERS

A. Stainless steel.

2.3 BUTT HINGES

A. ANSI A156.1.

B. Quantity per Door Leaf (Minimum):

Door Height	Hinges
Up to 5'-0"	1 pair
5'-1" to 7'-7"	1-1/2 pair
7'-7" to 10'-0"	2 pairs
10'-1" to 12'-6"	2-1/2 pairs

C. Hinge Height (Minimum):

Door Width	Hinge Height
Up to 3'-0"	4-1/2"
3'-1" to 4'-0"	5"
Over 4'-0"	6"

D. Width: Minimum for clearance of trim and 180-degree swing.

E. Exterior Hinges: Nonremoveable pin.

F. Joint Tolerance: 0.012-inch maximum, gauged in CLOSED position.

G. Finish: Satin stainless steel No. 630.

H. Types and Manufacturers:

No.	Type Description	Stanley	Mc-Kinney	Lawrence	ANSI/ BHMA
H1	Regular weight, two ball-races, full mortise, stainless steel	FBB191-32D	TB2314	BB4101-32D	A5112
H3	Pivots furnished by door manufacturer, including middle pivot				
H4	Extra heavy-weight, four ball races, full mortise, stainless steel	FBB199-32D	T4B3386	BB5151-A	A5111

2.4 LOCKS AND LATCH SETS

A. Mortise Locks: ANSI A156.13, Series 1000, Grade 1 and A115.1.

1. Materials: Brass or stainless steel.
2. Trim: Wrought or forged lever handles and roses.
3. Core Cylinders: Interchangeable, removable; minimum of six pins.
4. Bolt Throw: 5/8-inch minimum.
5. Lever Backset: 2-3/4 inches.
6. Manufacturer: Best.

B. Finish: Satin chromium-plated No. 626.

C. Locks and Latches: No substitutions allowed.

D. Types and Manufacturers:

No.	Type Description	Best	ANSI/ BHMA
L1	Mortise entrance lock with lever handle	35H7F16J	F12, F13
L7	Deadlock	83T7K	E2151
L17	V series magnetic stripe electronic lock with software, controller, card encoder and cards	35HV7FV16MS	
L18	Mortise office lock with lever handle	35H7E16J	

E. Keying:

1. Lock Cylinders: Operate by a grand master key system that allows for future expansion.
2. Keylocks: Key new locks into existing Best master key system.
3. Keys: Two per lock (1 keyed, 1 blank); tag with schedule information.
4. Master Keys: Four; send by registered mail to CONTRACTING OFFICER.
5. Furnish lock manufacturer's removable core maximum security keying system.

2.5 CONSTRUCTION KEY SYSTEM

A. Removable construction core system for locks.

B. See Article MANUFACTURER'S SERVICES under Part 3, EXECUTION.

2.6 CLOSERS

A. ANSI A156.4.

B. Size closers in accordance with manufacturer's standards. Mount regular arm closers on pull side of doors. Mount parallel arm closers on push side of doors. On pair of doors provide closer on active leaf only, unless noted otherwise.

C. Finish: Painted finish to match bronze.

D. Types and Manufacturers:

No.	Type Description	LCN	Sargent	ANSI/ BHMA
C1	Regular arm	4010 Series	350 Series	C02011
C4	Parallel arm with integral stop	4110 Cush-N-Stop Series	350-PS Series	C02021
C6	Parallel arm with integral stop and hold-open	4110H Cush-N-Stop Series	350-PSH Series	C02061

2.7 PUSH-PULLS

A. Solid metal, not plated.

B. Finish: Satin stainless steel No. 630, unless indicated otherwise.

C. Plates: Beveled four edges, square corners.

D. Pulls: Bolted through door.

E. Push Plates: Countersink pull-through bolts and cover with push plate.

F. Types and Manufacturers:

No.	Type Description	BBW	Baldwin
P1	8" x 3/4" Pull handle on plate: 0.050" x 4" x 16", and push plate: 0.050" x 8" x 16"	1017-3B and 47-G	2367 and 2125

2.8 STOPS AND HOLDERS

A. ANSI A156.16.

B. Machine Screws: In threaded anchors at concrete or masonry.

C. Self-Tapping Screws: At stud partitions, wood, or metal mountings.

D. Metal Risers: For mounting at carpet floors.

E. Finish: Satin chromium-plated No. 626.

F. Types and Manufacturers for Each Leaf:

No.	Type Description	BBW or GJ	Baldwin	ANSI/ BHMA
S2	Wall bumper	WC9X or WC9T	4031 or 4032	L02241 or L02251
S3	Wall stop-holder	W140 or W141X	4090 or 4091	L02251 or L01351
S4	Floor stop-holder	F823X	4096	L01371
S6	Overhead door holder	GJ90M	Sargent 590	C012511

2.9 BOLTS

A. ANSI A156.16.

B. Finish: Satin chromium-plated No. 626.

C. Types and Manufacturers:

No.	Type Description	Stanley	Lawrence	ANSI/ BHMA
B1	Top and bottom flush bolts	393-1/2	280	L04201

2.10 KICKPLATES

A. Solid metal, not plated. Bevel four edges.

B. Width of door leaf less 1-1/2 inches at single leaf and less 1 inch at pairs.

C. Finish: Satin stainless steel No. 630.

D. Types and Manufacturers: Builders Brass Works, Baldwin, or Cipco as follows:

1. K1 10 inches high by 0.05-inch thick.

2.11 THRESHOLDS

A. Thresholds: One-piece full width of opening; extend beyond jamb where indicated.

B. Provide with stainless steel machine screws in threaded expansion anchors at concrete.

C. Finish: Mill finish aluminum, unless indicated otherwise.

D. Types and Manufacturers:

No.	Type Description	Pemko	Reese
T2	Saddle (serrated, 4" x 1/4")	270A	S404A
T6	Panic exit saddle	2005AV	S483AV

2.12 WEATHERSTRIP

A. Finish: Dark bronze anodized aluminum, unless indicated otherwise.

B. Seal Types and Manufacturers:

No.	Type Description	Pemko	Reese
W1	Rubber or vinyl bulb at jambs and head, and at meeting stiles of pairs	S88D	797B
	Door shoe or sweep	309DP	DB590DP
	Smoke gasket	HSS2000	Zero FS3003
W2	Rubber or vinyl bulb at jambs and head, and at meeting stiles of pairs	S88D	797B
	Door shoe	222DV	DB596DF
W3	Rubber vinyl bulb at jambs and head, and at meeting stiles of pairs	S88D	797B
	Door shoe or sweep with drip	3452DP	DB597DP
	Interlocking watershed	68DR & 347D	202D & 203D
W5	Weather-stripping furnished by door manufacturer		

2.13 MISCELLANEOUS ITEMS

A. Provide as indicated in Hardware Set.

M7	Coordinator		
		GJ	Ives
	Model	COR-65	469

2.14 SILENCERS

A. Ives, Glynn-Johnson.

B. At metal frame of each hinged door that does not have seals scheduled.

C. Three at single leaves and two at pairs.

2.15 TEMPLATES

A. Fabricate to template hardware applied to metal doors and frames.

B. Ensure that required templates are furnished to the various manufacturers for fabrication purposes.

C. Templates: Make available not more than 10 days after receipt of approved Hardware Schedule.

2.16 EXIT AND FIRE DOORS

A. Exit Doors: Always openable from the inside by the simple turn of a lever handle or push on a panic bar without use of a key or any special knowledge or effort, to include each leaf of door pairs.

B. Hardware for Fire Doors: Underwriters Laboratories Inc., Fire Protection Equipment List.

2.17 KEY CONTROL SYSTEM

1. Complete system with standard components such as envelopes, transient key tags, reserve key tags, receipts and holders, and card index added to existing cabinet in Flight Simulator Building. Match existing key control system.

PART 3 EXECUTION

3.1 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Make Work neat and secure, develop full strength of components, and provide proper function.

C. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.

D. Latchbolts: Install to engage in strikes automatically, whether activated by closers or manually.

1. In no case shall additional manual pressure be required to engage latchbolt in strike.

E. Stops and Holders: Set to allow doors to open as far as possible.

F. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.

G. Thresholds:

1. Cope ends neatly to profile of jamb.
2. Set in sealant and seal ends to jambs.

H. Hardware: Adjust for easy, noise-free operation.

I. Replace damaged hardware items.

3.2 MOUNTING DIMENSIONS

A. Standard Door Hardware Locations: As recommended and published by the Door and Hardware Institute, except as noted or detailed otherwise.

B. Door Silencers: Install 3 inches from top and bottom of jamb and 1 inch above strike at single doors, and 3 inches from edges of doors in head for pairs of doors.

3.3 MANUFACTURER'S SERVICES

A. Deliver permanent lock cores to the site.

B. Remove temporary construction cores and insert permanent cores.

C. Inspect each lock set to ensure permanent cores are operating satisfactorily.

D. Deliver to CONTRACTING OFFICER change and control keys for the permanent system.

E. Return temporary construction cores to the manufacturer.

F. Furnish manufacturer's representative for the following services at site or classroom as designated by CONTRACTING OFFICER, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance, inspection, and Manufacturer's Certificate of Proper Installation.
2. 1 person-day for functional and performance testing.

3.4 PROTECTION

A. Cover and protect exposed surfaces of hardware during installation and until Substantial Completion.

B. Fit, dismantle, and reinstall finish hardware as required for finish painting work.

C. Protect and prevent staining of hardware during construction in accordance with manufacturer's recommendations.

D. Remove protective measures and permanent lock cylinders installed prior to final cleaning.

3.5 DOOR SCHEDULE

A. The Door Schedule on the Drawings is a guide to functional requirements of each opening.

B. Provide finish hardware as scheduled. Sizes omitted shall be as recommended by the manufacturer.

3.6 HARDWARE SETS

HDW-1:	**Item**	**Type**
	3 Pivots	H3
	1 Lock	L17
	1 Closer	C6
	1 Threshold	T6
	1 Weather-strip set	W5
HDW-2:	**Item**	**Type**
	3 Pivots	H3
	1 Lock	L1
	1 Closer	C6
	1 Threshold	T6
	1 Weatherstrip set	W5

HDW-3:	Item	Type
	8 Hinges	H4
	1 Lock (active leaf)	L1
	2 Closers	C4
	1 Bolt set (inactive leaf)	B1
	2 Kickplates	K1
	1 Threshold	T6
	1 Weather-strip set	W3
	1 Coordinator	M7
HDW-4:	**Item**	**Type**
	3 Hinges	H1
	1 Lock	L18
	1 Wall stop	S2
	1 Kickplate	K1
	1 Threshold	T2
	1 Weatherstrip set	W2
HDW-5:	**Item**	**Type**
	3 Hinges	H1
	1 Dead bolt at 109A only	L7
	1 Push-pull	P1
	1 Closer	C1
	1 Wall stop-holder	S3
	1 Kickplate	K1
HDW-6:	**Item**	**Type**
	3 Hinges	H1
	1 Lock	L18
	1 Closer	C1
	1 Floor stop-holder	S4
	1 Kickplate	K1
	1 Threshold	T2
	1 Weatherstrip set	W2

HDW-7:	Item	Type
	3 Hinges	H1
	1 Lock	L18
	1 Closer	C1
	1 Wall stop	S2
	1 Kickplate	K1
	1 Threshold	T2
	1 Weatherstrip set	W1
HDW-8:	**Item**	**Type**
	3 Hinges	H1
	1 Lock	L18
	1 Closer	C1
	1 Wall stop-holder	S3
	1 Kickplate	K1
	1 Threshold	T2
	1 Weatherstrip set	W2
HDW-9:	**Item**	**Type**
	6 Hinges	H1
	1 Lock (active leaf)	L1
	1 Closer (active leaf)	C6
	1 Overhead door holder (inactive leaf)	S6
	1 Bolt set (inactive leaf)	B1
	2 Kickplates	K1
	1 Threshold	T6
	1 Weatherstrip set	W3

END OF SECTION

SECTION 08800
GLAZING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Architectural Manufacturers Association (AAMA):
   a. 800, Voluntary Specifications and Test Methods for Sealants.
   b. 804.1, Specification for Ductile Back-Bedding Glazing Tapes.
2. American National Standards Institute (ANSI): Z97.1, Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test.
3. American Society for Testing and Materials (ASTM):
   a. C542, Standard Specification for Lock-Strip Gaskets.
   b. C920, Standard Specification for Elastomeric Joint Sealants.
   c. C1036, Standard Specification for Flat Glass.
   d. C1048, Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated glass.
   e. E774, Standard Specification for Sealed Insulating Glass Units.
4. Code of Federal Regulations (CFR): 16 CFR 1201, Safety Standard for Architectural Glazing Materials.
5. Flat Glass Marketing Association (FGMA):
   a. Glazing Manual.
   b. Glazing Sealing Systems Manual.
6. Sealed Insulating Glass Manufacturer's Association (SIGMA): Standards and Specifications, Number 65-7-2.
7. Underwriters Laboratories Inc. (UL).

1.2 SUBMITTALS

A. Shop Drawings:

1. Complete schedule of glass and glazing material to be used for each purpose.
2. Details of methods of glazing for each type of glazing condition.
3. Catalog cuts of glazing materials with inclusion of glass edge cutting procedures.

B. Quality Control Submittals: Documentation of glazer's previous experience and manufacturer's approval.

C. Factory Label Glass: Nonlabeled glass will be rejected.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Storage:

1. Support cases on both sides when stored vertically.
2. After unpacking, place interleaving protection between lites.
3. Keep glass and interleaving dry by storing inside where temperatures are above dewpoint, or if outside storage is necessary, cover the glass interleaving with opaque tarpaulins or plastic and inspect periodically. Wet interleaving can stain glass.
4. Avoid exposing stored glass to direct sunlight.

B. Handling:

1. Stack individual lites on edge and lean them against sturdy uprights at a slope of 5 to 7 degrees from vertical.
2. Cushion the bottom edges with soft, firm pads free of dirt, grit, glass chips, or other foreign material.
3. Do not rotate or cartwheel insulating glass units over their corners. Use a turning device such as a rolling block if units must be rotated.

1.4 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of Work specified in this Specification section found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Products of the following manufacturers, that meet these Specifications, may be used on this Project:

1. ASG Industries, Inc.
2. Libbey-Owens-Ford Glass Co.
3. PPG Industries, Inc.
4. Guardian Industries, Corp.
5. Monsanto Co.
6. Panlam Industries.
7. Viracon, Inc.

2.2 GLAZING MATERIALS

A. Tempered Float Glass (TG): ASTM C1048, Kind FT, Condition A, Type I, Class 1, clear glass, Glazing Quality B; meeting ANSI Z97.1 and 16 CFR 1201, CI or CII, as applicable; 6-mm minimum thickness.

B. Wire Glass (WG): ASTM C1036, Type II, Class 1, Form 1, glazing quality, clear float, UL approved, meeting ANSI Z97.1, with 0.020-inch diameter welded wire in diamond mesh pattern embedded in 6-mm thickness.

C. Insulating Glass (IG): Insulating glass units with 1/2-inch air space, specified tinted glass outboard and clear glass inboard, each sheet 5-mm minimum thickness meeting ASTM E774, Class C, warranted by manufacturer against failure of edge sealing for minimum 5 years from date of manufacture.

D. Insulating Tempered Glass (ITG): Insulating glass units with 1/2-inch air space, specified tinted glass outboard and clear glass inboard, each sheet specified tempered float glass, warranted by manufacturer against failure of edge sealing for minimum 5 years from date of manufacture.

E. Tinted glass: Match existing Flight Simulator Training Facility tint color.

2.3 ANCILLARY MATERIALS

A. Setting Blocks: Neoprene or EPDM, 70 Shore A durometer hardness, chemically compatible with sealant used.

B. Glazing Tape: Polyisobutylene, meeting AAMA 804.1, color as selected.

C. Glazing Channels: Resilient EPDM or vinyl gaskets as provided with aluminum frames to be glazed.

D. Glazing Sealant: One-component nonsag silicone elastomeric sealant ASTM C920, Type S, Grade NS, Class 25, Use G, or AAMA 800.

E. Gaskets: Preformed Lock-Strip or “zipper” type glazing gaskets meeting ASTM C542, as manufactured by:

1. F. H. Maloney Co.; Lock-Strip.
2. Standard Products Co.; Stanlok.

PART 3 EXECUTION

3.1 PREPARATION

A. Do not perform glazing work in damp, foggy, or rainy weather, or when temperatures are not within range recommended by FGMA “Glazing Manual”.

B. Surfaces: Smooth, even, sound, dry, and clean.

C. Priming: Complete and cured.

D. Measure size of frames to receive glass and compute actual glass size allowing for edge clearances.

E. Use wire glass in all glazed openings in labeled fire doors and tempered glass in all other doors, transoms, and sidelights.

3.2 INSTALLATION OF GLAZING

A. General: Follow recommendations of glass manufacturer and FGMA "Glazing Sealing Systems Manual" and the following:

1. Cutting:
   a. Make concealed edges clean, straight cut, and free from chips and fissures.
   b. Shop cut all glass. Nipping glass on job not allowed.
   c. Allow for maximum grip on all edges.
2. Positioning Glass:
   a. Set glass with equal bearing on entire width of pane.
   b. Position sheets of glass with setting blocks.
   c. Set tong marks of tempered glass at bottom of installed sheet.
   d. Orient pattern and draw of glass pieces in same direction.
   e. Place glass waves parallel to floor.
   f. Set smooth side to exterior.
3. Glazing: In accordance with FGMA "Glazing Manual" and window or frame and glass manufacturers' printed instructions.
4. Glass shall not move or rattle.

3.3 HOSE TEST

A. Use 3/4-inch minimum hose without nozzle. With full stream, flood glazing from bottom to top.

B. Correct any leaks disclosed by hose test by reglazing and retesting until eliminated.

3.4 CLEANING

A. Leave glass and glazing in undamaged condition and ready for final cleaning.

B. Remove excess glazing compound from installed glass.

C. Remove labels from glass surface at time of final cleaning.

D. Wash and polish both faces of glass.

3.5 PROTECTION OF COMPLETED WORK

A. Protection:

1. Keep glass free from contamination by materials capable of staining glass.
2. Install tape across lights secured to frames or structure.
3. No tape or marking allowed on glass.

B. Replacements and Repairs:

1. Prior to Substantial Completion, replace broken, defective, or scratched glass and repair damaged compounds.

END OF SECTION

SECTION 09200
LATH AND PLASTER

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. A641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   b. C150, Standard Specification for Portland Cement.
   c. C841, Standard Specification for Installation of Interior Lathing and Furring.
   d. C847, Standard Specification for Metal Lath.
   e. C897, Standard Specification for Job-Mixed Portland Cement-Based Plasters.
   f. C926, Standard Specification for Application of Portland Cement-Based Plaster.
   g. C1063, Standard Specification for Installation of Lathing and Furring for Portland Cement-Based Plaster.

1.2 SUBMITTALS

A. Shop Drawings: Detailed control joint layout.

B. Manufacturer’s Literature.

C. Quality Control Submittals: Documentation of lath and plaster applier's successful experience for past 5 years on projects of equal size and scope.

1.3 QUALITY ASSURANCE

A. Field Samples:

1. Prepare a 4-foot by 4-foot sample panel of each plaster system on similar substrate to illustrate surface finish.
2. Approved panels shall establish a standard of quality and finish texture by which similar work will be evaluated.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Keep materials dry; store off ground, under cover, and away from damp places.

B. Protect accessories and metal goods against deformation, breakage, staining, and rusting.

1.5 ENVIRONMENTAL CONDITIONS

A. Temperature: Maintain uniform temperature above 55 degrees F for 24 hours before, during, and after application in areas receiving lathing and plastering.

B. Ventilation:

1. Provide ventilation to properly dry plaster during and after its application.
2. Use temporary air circulators in enclosed areas lacking natural ventilation.

PART 2 PRODUCTS

2.1 FRAMING FOR SUSPENDED CEILINGS

A. Carrying Channels: Cold-rolled steel, 16-gauge, free of rust, coated with factory-applied rust-inhibitive paint or zinc, 1-1/2 inches deep, weighing not less than 475 pounds per 1,000 linear feet.

B. Furring Channels: Cold-rolled steel, 16-gauge, free of rust, coated with factory-applied rust-inhibitive paint or zinc, 3/4-inch deep, weighing not less than 300 pounds per 1,000 linear feet.

C. Tie Wire: Galvanized, soft annealed steel, ASTM A641, 18-gauge minimum.

D. Hanger Wire: Galvanized, soft annealed steel, ASTM A641, 8-gauge minimum.

2.2 LATH

A. Expanded Metal Lath: ASTM C847.

1. Diamond Mesh: Galvanized steel, 3.4 pounds per square yard.

B. Fasteners for Metal Lath: Galvanized nails or staples of the type recommended by the lath manufacturer.

2.3 ACCESSORIES

A. For Portland Cement Plaster Systems: Galvanized steel or polyvinyl chloride, size suitable for the thickness of the plaster.

ACCESSORIES FOR PORTLAND CEMENT PLASTER-SYSTEMS			
Material	**Metalex Keene**	**Vinyl Tech**	**Fry**
Corner bead	1-X	#4	PCM-75-75
Casing bead (exposed type)	J-Trim	#5C	JPM 75
Control joint	XJ15-3	#20X	PCS-75-25
Foundation screed	Drip Screed	#631	FWS-875
Expansion joint	#40	#20	PCS-75-25

2.4 PORTLAND CEMENT PLASTER MATERIALS

A. Portland Cement: ASTM C150, Type I.

B. White Cement: True waterproofed white Portland cement conforming to ASTM C150, Type I; Atlas Medusa white.

C. Fiber: Strands of alkaline-resistant chopped “Fiberglas” or goat or cattle hair or manila fiber of good quality, 1/2 inch to 2 inches long.

D. Sand: ASTM C897.

E. Integral Waterproofing: Sika Corp.; “Sika Red Label” liquid water repellant admixture.

2.5 MIXES

A. General:

1. Provide suitable mechanical mixers and measuring devices. Hand mixing will not be permitted.
2. Use potable water.
3. Thoroughly mix plaster ingredients.
4. Use mixed plaster within 1 hour after mixing. Retempering will not be permitted.
5. Do not allow material to remain overnight in mixers or mixing boxes.
6. Clean machines, boxes, tools, and equipment as required during the plastering operation.
7. At the end of the working day, clean up all tools and equipment.

B. Preparation of Lime Putty: Prepare lime putty from hydrated lime in conformance with the manufacturer's printed directions.

C. Portland Cement Plaster Mix Proportions:

1. Portland Cement Plaster for Interior Surfaces (All Coats): 1 part Portland cement by volume, 3 parts sand, 1/4 part lime putty.
2. Portland Cement Plaster for Exterior Surfaces:
   a. Proportions: Scratch coat and brown coat, 1 cubic foot Portland cement, 3-1/2 cubic feet base coat sand, 4/10 cubic foot lime putty. Finish coat, 1 cubic foot Portland cement white, 2 cubic feet selected sand, 4/10 cubic foot lime putty.
   b. Fiber: Add 2 pounds of fiber to each batch of the scratch and brown coat mix when used on metal lath or plaster mesh.
   c. Waterproofing: Add 1 quart of integral waterproofing to each batch of the brown and finish coats of exterior plaster. Increase quantity of waterproofing material when necessary to conform with the manufacturer's printed directions.

PART 3 EXECUTION

3.1 PREPARATION

A. Protection: Protect other portions of the Work.

B. Surface Preparation: Repair defective surfaces prior to starting Work.

3.2 SUSPENDED CEILING ERECTION

A. General:

1. Securely brace ceiling areas against sway.
2. Prevent runner and furring channel contact with masonry walls.
3. Provide 1-1/2-inch channels around all recessed lighting fixture openings to support fixtures.
4. Where Work of other trades interferes with normal spacing of hangers and carrying channels, install additional hangers or channels to properly suspend the ceiling.

B. Hanger Wires:

1. Space maximum 4 feet 0 inch on center in the direction of runners and within 6 inches of runner ends.
2. Securely attach to structure above and make full saddle tie to main carrying channels.
3. Connections shall develop the full strength of the wire.

C. Main Carrying Channels:

1. Space channels maximum 4 feet 0 inch on center and 6 inches from parallel walls; run channels at right angles to the length of the joists.
2. Overlap splices 12 inches minimum, interlock flanges, and securely tie near each end of splice with double loops of tie wire.

D. Furring Channels:

1. Attach furring channels to carrying channels at right angles, space at 16 inches OC.
2. Securely saddle tie furring to the main channels at each crossing.
3. Overlap splices in cross-furring 8 inches minimum, interlock flanges, and securely tie near each end of splice with two loops of tie wire.

3.3 APPLICATION OF METAL LATH TO FRAMING

A. Apply to framing in strict accordance with ASTM C841 and the manufacturer's printed directions.

3.4 APPLICATION OF METAL LATH FOR EXTERIOR

A. Conform to ASTM C1063.

B. Cover framing with underlayment before application of lath.

C. Install underlayment horizontally with upper sheet overlapping the lower by 3 inches (shingle fashion) to shed moisture.

D. Coordinate Work with metal flashings.

E. Apply metal lath over the underlayment in conformance with manufacturer's printed directions.

F. Install accessories.

3.5 JOINTS BETWEEN DIFFERENT MATERIALS USED FOR PLASTER BASE

A. Where metal lathed surfaces join surfaces of other materials to be used for a plaster base, extend metal lath across the junction, lapping at least 4 inches each side of joint for the entire height or width.

3.6 ACCESSORIES

A. Install accessories plumb or level, straight, and true to line.

B. Tie with wire or nail at 12-inch intervals to metal or gypsum lath as required to accomplish the construction.

C. Provide corner beads at external angles, casing beads where indicated and where plaster abuts unplastered surfaces, metal screeds, and other accessories as shown and required.

3.7 PORTLAND CEMENT PLASTER APPLICATION

A. Conform to ASTM C926, except as specified.

B. Scratch Coat: Apply with sufficient pressure to completely embed the metal reinforcement or to force it into the masonry surfaces.

1. Thickness: Full 3/8-inch coat.
2. Cross-scratch and after initial set damp-cure for 48 hours, or until brown coat is applied.

C. Brown Coat: After scratch coat has set, but not less than 24 hours after application, apply over the dampened scratch coat with sufficient pressure to form a good bond.

1. Thickness: Full 3/8-inch coat.
2. Rod and level brown coat and roughen with a broom in preparation for the finish coat.
3. After the coat has set, damp-cure for a period of 7 days or until the finish coat is applied.

D. Finish Coat: Apply not less than 7 days after the brown coat, and keep damp for 2 consecutive days thereafter.

1. Give Portland cement plaster a hand-troweled–textured finish matching existing.
2. Finish plaster to a true, hard surface texture of the approved sample panel.
3. After the coat has set, damp-cure for 48 hours by means of a fog spray that will keep the surface continuously damp.

3.8 APPLICATION THICKNESSES

A. Provide thicknesses in table below, measured from the face of plaster base to finished plaster surface.

B. Install wood or metal grounds, or plaster screeds, to assure required thickness.

C. Increase plaster thickness where necessary to meet building code requirements.

Plaster Base	Thickness of Plaster Including Finish Coat (Inches)
All other types of lath	1/2 minimum
Unit masonry	5/8 minimum
Vertical monolithic concrete surfaces	5/8 maximum
Horizontal monolithic concrete surfaces	3/8 maximum 1/8 minimum
Metal lath (Portland cement plaster)	3/4 minimum
Masonry	5/8 minimum

3.9 FIELD QUALITY CONTROL

A. COTR/CM will take samples from plaster work in-place to verify conformance with intent of Contract Documents. Areas represented by samples that show oversanding will be rejected.

3.10 REPAIRING DEFECTIVE WORK

A. Plaster surfaces containing cracks, blisters, pits, checks, or discoloration's will be considered defective and will not be acceptable.

B. Patching of defective Work will be permitted only when approved by the COTR/CM; match existing in texture and color.

C. Cut and repair plaster for installation of omitted Work.

D. Patch lath and plaster what has been cut or damaged due to installation of materials or equipment after the plaster has been applied.

3.11 CLEANING

A. Remove excess plaster from building surfaces and clean.

END OF SECTION

SECTION 09250
GYPSUM BOARD

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. A641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   b. C36, Standard Specification for Gypsum Wallboard.
   c. C475, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
   d. C645, Standard Specification for Non-Load (Axial) Bearing Steel Studs, Runners (Track), and Rigid Furring Channels for Screw Application of Gypsum Board.
   e. C754, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum.
   f. C840, Standard Specification for Application and Finishing of Gypsum Board.
   g. C1002, Standard Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases.
   h. C1047, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
2. Gypsum Association (GA):
   a. 214, Levels of Gypsum Board Finishes.
   b. 216, Recommended Specifications for Application and Finishing of Gypsum Board.

1.2 SUBMITTALS

A. Shop Drawings:

1. Control joint pattern proposed for gypsum board.
2. Control joint pattern proposed for gypsum soffit.
3. Manufacturer's list of items and materials proposed for use, with descriptive literature for each system used.

1.3 QUALITY ASSURANCE

A. General: Regardless of the minimum specifications herein, utilize materials and applications recommended by the manufacturer.

B. Applicator's Qualifications: Use only workers regularly employed in this type of work who can show experience in the application of similar materials and the specific systems specified.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver fire-rated materials bearing testing agency label and required fire classification numbers.

B. Storage:

1. Store materials inside, under cover, stacked flat, off floor.
2. Stack gypsum board so that long lengths are not over short lengths.
3. Avoid overloading floor system of storage area.
4. Store adhesives and finishing compounds in dry areas; protect against freezing at all times.

1.5 ENVIRONMENTAL CONDITIONS

A. Temperature:

1. In areas receiving gypsum board installation, maintain temperature range between 55 and 70 degrees F for 24 hours before, during, and after gypsum board and joint treatment application.
2. In areas receiving veneer plaster, where outside air temperature is less than 50 degrees F, maintain interior temperature range between 50 degrees F and 80 degrees F for a period of 1 week before, during, and 1 week after application of veneer plaster, base, and joint treatment.

B. Ventilation:

1. Provide ventilation during and following adhesives and joint treatment applications.
2. Use temporary air circulators in enclosed areas lacking natural ventilation.
3. Keep air circulation at a minimum level during veneer plastering to avoid excessive drying.
4. Under slow drying conditions, allow additional drying time between coats of joint treatment.
5. Protect installed materials from drafts of ambient air during hot, dry weather.

PART 2 PRODUCTS

2.1 GYPSUM BOARD

A. Regular Board (GWB): ASTM C36, 5/8-inch thick with tapered edges, unless noted otherwise on Drawings.

B. Fire-Rated Board (GWBX): ASTM C36, Type X, 5/8-inch thick with tapered edges.

2.2 FASTENERS FOR GYPSUM BOARD

A. Screws: ASTM C1002, self-drilling, self-tapping, bugle head, for use with power-driven tool.

1. Type S, 1-inch long for gypsum board to sheet metal.
2. Type W, 1-1/4 inches long for gypsum board to wood.

2.3 JOINT TREATMENT MATERIALS

A. Joint Tape for General Interior Applications: ASTM C475, perforated tape.

B. Joint Compound for General Interior Applications: ASTM C475, all-purpose, ready-mixed compound.

2.4 ANCILLARY MATERIALS

A. Adhesives: As recommended by gypsum board manufacturer for intended use.

B. Sound Attenuation Blankets: As specified in Section 07210, BUILDING INSULATION.

C. Acoustical Sealant: Nonsetting and nonstaining as manufactured by DAP, United States Gypsum, Tremco, or Ohio Sealants, Inc.

2.5 METAL ACCESSORIES

A. ASTM C1047, Zinc-Coated Metal.

1. Corner Bead: 1-1/4 inch by 1-1/4 inch:
   a. United States Gypsum; Dur-A-Bead.
   b. Gold Bond; standard corner beads.
2. Edge Trim:
   a. United States Gypsum; 200B metal trim.
   b. Gold Bond; No. 200 casing bead.

3. Metal Control Joint:
   a. United States Gypsum; No. 093.
   b. Gold Bond; E-Z strip control joint.

B. Wire:

1. Tie Wire: Galvanized, soft annealed steel, ASTM A641, 18-gauge minimum.
2. Hanger Wire: Galvanized, mild steel, ASTM A641, 8-gauge minimum.

2.6 LIGHT-GAUGE METAL FRAMING

A. Carrying Channels: Cold-rolled steel, 16-gauge, free of rust, coated with factory-applied rust-inhibitive paint, 1-1/2 inches deep, weighing not less than 475 pounds per 1,000 linear feet.

B. Furring Channels: Roll-formed hat shaped section of 25-gauge galvanized steel with a face width of 1-3/8 inches and a depth of 7/8 inch.

C. Resilient Furring Channels: Roll-formed section of 25-gauge galvanized steel with face width of 1-1/2 inches designed for resilient attachment of gypsum board to framing.

1. Manufacturers and Products:
   a. United States Gypsum; RC-1 channel.
   b. Donn Corp.; DG-8 resilient channels.

2.7 NONSTRUCTURAL METAL FRAMING MEMBERS

A. ASTM C645, 20-gauge galvanized I and C-studs with 1-5/8-inch flanges, and ancillary items for interior wall framing, shaft walls, and ceiling framing.

B. Dry wall studs, tracks, shaft wall studs, Z-furring channels, and accessories as manufactured by:

1. United States Gypsum.
2. Dale/Incor.
3. Gold Bond.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect surfaces to receive gypsum board and related materials before beginning work and report to COTR/CM any defects in such work which will adversely affect the quality of work specified herein.

3.2 PREPARATION

A. General: Provide, install, and maintain necessary scaffold, staging, trestles, planking, and temporary heating, lighting, and ventilation as necessary for the duration of the gypsum board work.

B. Protection: Protect work of other trades.

C. Coordination:

1. Coordinate work with that of other trades. Check specifications and drawings of other trades to determine parts of work requiring coordination.
2. Cut and repair gypsum board systems for installation of omitted work.

D. Surface Preparation: Repair defective surfaces prior to starting work. Prepare as specified for application of specific materials.

3.3 ERECTION OF SUSPENDED CEILING

A. General:

1. Securely brace all ceiling areas against sway as required by code for seismic control.
2. Let neither runner nor furring channels into or come in contact with masonry walls.
3. Provide 1-1/2-inch channels around recessed lighting fixture openings to support fixtures.

B. Hangers:

1. Space not over 4 feet 0 inch on center (OC) in direction of runners and within 6 inches of ends of runners.
2. Securely attach to structure above and provide for full saddle tie to main runner at indicated height.
3. Install additional hangers at ends of each suspension member and at light fixtures, 6 inches from vertical surfaces.
4. Do not splay wires more than 5 inches in a 4-foot vertical drop.
5. Provide four-way wire splays at 45 degrees from main runner to support structure for every 144 square feet of ceiling area to prevent sway.
6. Wrap wire minimum three times horizontally, turning ends upward.

7. Where hanger wires cannot be hung vertically from structure above because of ducts, pipes, cable trays, or other interferences, provide trapezes of steel channels (minimum 2-inch deep, 16-gauge cold-rolled carrying channels) hung on steel rods or 8-gauge wire from structural members above. Hang ceiling wires from trapezes or similar members supporting ducts or pipes. Do not hang directly from ducts or pipes.

C. Main Runner Channels:

1. Run main runner channels spaced not more than 4 feet OC, and 6 inches from parallel walls, at right angles to the length of the joists.
2. Overlap splices in main runners 12 inches minimum, interlock flanges, and securely tie near each end of splice with double loops of tie wire.

D. Furring Channels:

1. Attach furring channels to main runners at right angles, space at 16 inches OC.
2. Securely saddle tie furring to the main runners at each crossing or equivalent clips or attachments.
3. Splices in Cross-Furring: Lap 8 inches minimum, interlock flanges, and securely tie near each end of splice with two loops of tie wire.

3.4 ERECTION OF LIGHT-GAUGE NONSTRUCTURAL METAL FRAMING

A. Layout: Align partitions as shown on the Drawings.

B. Tracks:

1. Attach metal runner tracks to floor slabs with suitable fasteners located 2 inches from each end and spaced not more than 24 inches OC.
2. Where partitions terminate at suspended or framed ceilings attach top tracks to suspended ceiling with toggle or molly bolts spaced 24 inches OC.
3. Where partitions terminate at underside of concrete or metal decking attach deflection channels to substrate with suitable fasteners located 2 inches from each end and spaced not more than 24 inches OC. Locate partition top tracks within deflection channels with a minimum top clearance of 1 inch. Do not attach track to channel.

C. Studs:

1. ASTM C754.

2. Following manufacturer's printed instructions, position studs vertically, engaging floor and ceiling tracks and spaced as noted on Drawings.
3. Splice: When necessary, use 8-inch nested lap and one positive attachment per stud flange.
4. Place in direct contact with doorframe jambs, abutting partitions, and partition corners. Provide for anchorage of doorframes to studs.
5. Anchor all studs for shelf-walls and those adjacent to window and doorframes, partition intersections, and corners to ceiling and floor runner flanges. Securely anchor studs to jamb and head anchor clips of door or borrowed-light frames by bolt or screw attachment.
6. Over metal door and borrowed-light frames, place horizontally a cut-to-length section of runner, with a web-flanged bend at each end, and secure with one positive attachment per flange. Position a cut-to-length stud (extending to ceiling runner) at vertical panel joints over doorframe header.
7. Locate studs at abutting construction, partition intersections, and partition corners.
8. Spacing: At 16 inches OC, unless otherwise required by manufacturer.
9. At Doorframes and Cased Openings:
   a. Full height double studs, No. 20-gauge minimum, secured to jamb anchors by bolts, screws, or welds.
   b. Header Track: Secure to frame head anchors and double studs.
   c. Provide double channel stiffeners through studs above frame and extend at least one stud space beyond each jamb.
10. Windows: Similar framing to door openings with stiffeners both above and below.
11. Wall Mounting Accessories: Provide channels, horizontal studding, No. 16-gauge sheet 8 inches by 2 inches greater than stud spacing, or other members within walls as required to provide secure and adequate support.

D. Furring:

1. Space furring channels the same as studs or as shown.
2. Around columns and beams construct furring as shown using metal studs and furring channels securely tied together and anchored in-place.
3. Attach resilient furring channels to wood framing with screws.

3.5 APPLICATION OF GYPSUM BOARD

A. Inspection and Preparation:

1. Check framing for accurate spacing and alignment.
2. Verify that spacing of installed framing does not exceed maximum allowable for thickness of gypsum board to be used.

3. Verify that frames are set for thickness of gypsum board to be used.
4. Do not proceed with installation of gypsum board until deficiencies are corrected and surfaces to receive gypsum board are acceptable.
5. Protrusions of framing, twisted framing members, or unaligned members must be repaired before installation of gypsum board is started.

B. General:

1. Meet requirements of ASTM C840 and GA-216.
2. Joints: Use gypsum board of maximum lengths to minimize end joints. Stagger end joints when they occur. Locate end joints as far as possible from center of wall or ceiling. Abut gypsum board without forcing. Neatly fit ends and edges of gypsum board. Do not place butt ends against tapered edges.
3. Support ends and edges of gypsum board panels on framing or furring members except for face layer of double layer and where ends are back blocked and floated.
4. Use metal edge trim where gypsum board abuts another material and where shown or noted on Drawings.
5. Use cementitious board in toilet and janitor room walls behind ceramic tile and elsewhere as indicated on Drawings.
6. Follow manufacturer's recommendation of good practice.

C. Over Framing:

1. Apply gypsum board first to ceiling and then to walls for single layer horizontal application.
2. Use vertical application for fire-rated walls.
3. Fasten gypsum board securely to framing using double nailing, screw, or adhesive method.

D. Sound-Rated Partitions:

1. Fabricate and erect in accordance with manufacturer's printed instructions for the required rating.
2. Install attenuation blankets as detailed.
3. Seal with acoustical sealant perimeter edges of gypsum board, joints around penetrations, and other joints as noted.

3.6 JOINT SYSTEM

A. All exposed or cut edges shall be neatly finished with beads or trim.

B. Interior Gypsum Board: Conform to ASTM C840.

C. Required: On exposed gypsum board, under ceramic tile and wall covering, and behind casework.

D. Prefill: Fill V-grooves formed by abutting rounded edges of gypsum board with prefill joint compound. Fill V-joint flush and remove excess compound beyond groove. Leave clear depression to receive tape. Permit prefill joint compound to harden prior to application of tape.

E. Taping and Finishing Joints:

1. Taping or Embedding Coat: Apply compound in thin, uniform layer to joints and angles to be reinforced. Apply reinforcing tape immediately. Center tape over joint and seat tape into compound. Leave approximately 1/64-inch to 1/32-inch compound under tape to provide bond. Apply skim coat immediately following tape embedment but not to function as fill or second coat. Fold tape and embed in angles to provide true angle. Dry embedding coat prior to application of fill coat.
2. Filling Coat: Apply joint compound over embedding coat. Fill taper flush with surface. Apply fill coat to cover tape. Feather out fill coat beyond tape and previous joint compound line. For joints with no taper, feather out at least 4 inches on either side of tape. Do not apply fill coat on interior angles. Allow fill coat to dry prior to application of finish coat.
3. Finishing Coat: Spread joint compound evenly over and beyond fill coat on joints. Feather to smooth uniform finish. Apply finish coat to taped angles to cover tape and taping compound. Sand final application of compound to provide surface ready for decoration.
4. Filling and Finishing Depressions: Apply joint compound as first coat to fastener depressions. Apply at least two additional coats of compound after first coat is dry. Leave filled and finished depressions level with plane of surface.

F. Finishing Beads and Trim:

1. First Fill Coat: Apply joint compound to bead and trim. Feather out from ground to plane of the surface. Dry compound prior to application of second fill coat.
2. Second Fill Coat: Apply joint compound in same manner as first fill coat. Extend beyond first coat onto face of gypsum board. Dry compound prior to application of finish coat.
3. Finish Coat: Apply joint compound to bead and trim. Extend beyond second fill coat. Feather finish coat from ground to plane of surface. Sand finish coat to provide flat surface ready for decoration.

3.7 FINAL FINISHES

A. Levels of Finish: Conform to GA-214.

B. Level 1:

1. Taping or embedding coat only.
2. Use in concealed areas, and where indicated, unless a higher level is required for fire-resistive or sound-rated assemblies.

C. Level 3:

1. Taping, filling, and finishing coats.
2. Use on surfaces indicated to have ceramic tile.

D. Level 4:

1. Taping, filling, and finishing coats plus two separate coats applied over joints, angles, fastener heads, and trim accessories.
2. Sand between coats and after last coat.
3. Use on surfaces indicated to receive wall coverings.

E. Level 5:

1. Same as Level 4, plus a thin, smooth, uniform skim coat of joint compound, or product specially formulated for this purpose, over entire surface.
2. Produce surfaces free of tool marks and ridges, ready for decoration.
3. Use on surfaces not indicated otherwise, those indicated to receive gloss, semi-gloss, and nontextured flat paints, and where indicated.

3.8 ADJUST AND CLEAN

A. Clean: Remove droppings or texture overspray from walls, windows, and floor, leaving room clean for following trades.

B. Ridging:

1. Do not repair ridging until condition has fully developed, approximately 6 months after installation or one heating season.
   a. Sand ridges to reinforcing tape without cutting through tape.
   b. Fill concave areas on both sides of ridge with topping compound.
   c. After fill is dry, blend in topping compound over repaired area.
2. Fill cracks with compound and finish smooth and flush.

END OF SECTION

SECTION 09300
TILE

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. A108.1A, Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Paver Tile and Glazed Paver Tile installed with Portland Cement Mortar.
   b. A108.4, Ceramic Tile installed with Water-Resistant Organic Adhesives.
   c. A118.1, Dry-Set Portland Cement Mortar.
   d. A118.4, Latex-Portland Cement Mortar.
   e. A137.1, Ceramic Tile.
2. American Society for Testing and Materials (ASTM):
   a. A497, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
   b. C144, Standard Specification for Aggregate for Masonry Mortar.
   c. C150, Standard Specification for Portland Cement.
   d. C206, Standard Specification for Finishing Hydrated Lime.
   e. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   f. C847, Standard Specification for Metal Lath.
   g. C920, Standard Specification for Elastomeric Joint Sealants.
   h. D226, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
3. Tile Council of America (TCA):
   a. Handbook for Ceramic Tile Installation.
   b. Handbook for Limitations.

1.2 SUBMITTALS

A. Samples for color selection.

B. Manufacturer’s literature.

C. Quality Control Submittals:

1. Certification of Compliance: For tile, mortar, grouts, and adhesives.
2. Manufacturer's Instructions: For storage, mixing, application, cleanup, and use of proposed mortars, grouts, and adhesives.

3. Tile Manufacturer's Maintenance Guidelines: For OWNER's use in maintaining ceramic tilework specified herein.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Set and grout tile in Portland cement mortar when ambient temperature is at least 50 degrees F and rising. Follow ANSI A108.1A.

B. Comply with minimum temperature recommendations of manufacturers for bonding and grouting materials other than Portland cement mortar.

1.4 EXTRA MATERIALS

A. Tile: Furnish extra 2 percent of each tile used in clean, marked cartons for OWNER's future use.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Materials and products specified in this section shall be products of:

1. Crossville Ceramics, Cross Colors.
2. Daltile.

2.2 MATERIALS

A. Glazed Ceramic Mosaic Floor and Wall Tile: (CT) ANSI A137.1, Paltile, cushion edge, nominal face size 2 inches by 2 inches, face finished with matte glazed finish. Colors:
1. DK-14 Light Gray, field tile in rest rooms.
2. DK-23 Cobalt Blue, accent tile in Men’s Room.
3. DK-319 Deep Sea, accent tile in Women’s Room.

B. Unglazed Porcelain Stoneware Floor Tile (UPST): ANSI A137.1.

1. Manufacturer and Product: Flor Gres; Rocks COLORMASSA.
2. Size and Pattern: As shown on Drawings.
3. Color:
   a. Alpi, field tile.
   b. Appalachi, accent tile 1.
   c. Andes, accent tile 2.

C. Trim Shapes and Bases: Type, color, and finish to match wall tiles.

D. Marble Thresholds: White, honed Italian marble, Grade A, first quality, free from cracks, chips, stains, or other defects, uniform in tone and coloring; long, single bevel for thresholds.

E. Metal Lath and Accessories for Scratch Coat:

1. ASTM C847, diamond mesh, flat expanded, galvanized metal weighing not less than 2.5 pounds per square yard.
2. 18-gauge galvanized steel wire for lacing laps and securing metal lath to metal studs.

F. Portland Cement Mortar:

1. Portland Cement: ASTM C150, Type 1.
2. Sand: ASTM C144.
3. Hydrated Lime: ASTM C206 or ASTM C207, Type S.
4. Water: Clean and potable.
5. Mortar Bed Reinforcement: Either of the following:
   a. Welded Wire Fabric: ASTM A497, size 2-inch by 2-inch mesh, 16/16 wire.
   b. Expanded Metal Reinforcement: ASTM C847, galvanized with minimum weight of 1.8 pounds per square yard.

G. Cleavage Membrane: Either asphalt-saturated organic felt meeting ASTM D226, Type I, plain, or polyethylene sheeting with minimum thickness of 0.004 inch.

H. Dry-Set Mortar: ANSI A118.1, TCA Formula 759, gray.

I. Latex-Portland Cement Mortar: ANSI A118.4.

2.3 ANCILLARY MATERIALS

A. Expansion Joints:

1. Sealant: Silicone rubber type, meeting ASTM C920, Type S, Grade P, Class 25, Use T, color to match grout, with Shore A hardness of minimum 25 for joints in horizontal surfaces and minimum 35 in traffic areas.
2. Backup Material: Flexible and compressible type, nonstaining and compatible with sealants used.

B. Edge Strips: Stainless steel, Alloy 316 flat bar, 1/8 inch by depth of tile and mortar.

C. Sealer: Hillyard Chemical Co., Cemseal II or Thompson's Water Seal 101.

D. Tile Cleaner: Neutral tile cleaner solution acceptable to tile manufacturer.

E. Construction Paper: Heavy-duty, nonstaining Kraft paper.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine surfaces to receive ceramic tile, setting beds, or accessories prior to tile installation.

B. Correct defects or adverse conditions affecting quality and execution of tile installation.

C. Tolerances for Surfaces to Receive Tile:

1. Portland Cement, Dry-Set, Epoxy, and Furan Mortar Methods:
   a. Maximum Variation in Subfloor Surface: 1/4 inch in 10 feet.
   b. Maximum Variation in Vertical and Ceiling Surfaces: 1/4 inch in 8 feet.

D. Grounds, anchors, plugs, hangers, bucks, electrical and mechanical work, in or behind tile, to be installed prior to proceeding with tilework.

E. Protection: Protect adjoining work surfaces before tilework begins.

F. Make substrate firm, dry, clean, and free of oily or waxy films.

3.2 INSTALLATION

A. Prepare surfaces, fit, set, or bond tile, grout and clean tile in accordance with applicable requirements of ANSI Standards for setting method specified, except as otherwise noted.

B. Trim: Provide bases, caps, stops, returns, trimmers, and other shapes to finish installation.

C. Setting Wall Tile (Thin-Set Application):

1. On Cementitious Board Units Over Metal Studs: Meet TCA Method W244.
2. Use latex-portland cement.

D. Setting Floor Tile (Conventional Application):

1. On Subfloor: Meet TCA Method F111.
2. Use latex-portland cement grout.

E. Setting Floor Tile for UPST (Thin-set Application):

1. On Concrete: Meet TCA Method F113 with latex-portland cement grout.
2. Locate tile joints at floor control joints.

F. Setting Marble (Thin-Set Application):

1. Window Stool: ANSI A108.4. Install continuous lengths at each window opening.
2. Thresholds: Install thresholds with same method as adjacent tile.

G. Edge Strips:

1. At openings without thresholds and similar discontinuous edges of thin-set tile floors.
2. Where ceramic tile floors are adjacent to other flooring material at same level.
3. Where ceramic tile cove base is combined with other types of flooring.

3.3 CLEANING AND SEALING

A. Clean tile surfaces thoroughly on completion of grouting.

B. Remove grout haze, observing tile manufacturer's recommendations as to use of acid and chemical cleaners.

C. Rinse tilework thoroughly with clean water before and after using chemical cleaners.

D. Polish surface of glazed tilework with soft cloth.

E. After grout has cured for 10 days, clean and seal nonglazed tiles following sealer manufacturer's instructions and recommendations.

3.4 PROTECTION

A. From Construction Dirt:

1. Apply protective coat of neutral cleaner solution, 1 part cleaner to 1 part water, to clean completed tile walls and floors.

2. Cover tile floors with heavy-duty, nonstaining construction paper, masked in-place.
3. Just before substantial completion, remove paper and rinse protective coat of neutral cleaner from tile surfaces.

B. From Traffic:

1. Prohibit foot and wheel traffic from using newly tiled floors for at least 7 days.
2. Place large, flat boards in walkways and wheelways for 7 days where use of newly tiled floor with cement type grout is unavoidable.

END OF SECTION

SECTION 09510
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. A641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   b. C635, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
   c. C636, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
   d. E1264, Standard Classification for Acoustical Ceiling Products.

1.2 SUBMITTALS

A. Shop Drawings:

1. Detailed layout of grid indicating hanger spacing, fastening and splicing details, change in level details, and access location.
2. Manufacturer's recommendation for installation of system.
3. Manufacturer’s literature and specific design and technical data.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials with manufacturer's labels indicating brand name, pattern, size, thickness, and fire rating.

B. Store materials in original protective packaging to prevent soiling, physical damage, or wetting.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Maintain humidity of 65 percent to 75 percent in area where acoustical materials are to be installed for 25 hours before, during, and 25 hours after installation.

B. Maintain a uniform temperature of 55 to 70 degrees F prior to and during installation of materials.

1.5 EXTRA MATERIAL

A. Additional acoustical units from the same production run as installed equal to 1 percent of area.

PART 2 PRODUCTS

2.1 SUSPENSION SYSTEMS

A. All suspension system components, materials, and accessories shall be the product of a single manufacturer.

B. ASTM C635, Intermediate Duty:

1. Exposed Aluminum Tee Grid:
   a. Non-rated, light-duty, spaced to fit lay-in panels.
   b. Color: White.
   c. Exposed Flangewidth: 9/16-inch.
   d. Edges: Single molding to match grid.
   e. Manufacturers: Armstrong; Exposed Tee Grid.
2. Hanger Wire: ASTM A641, minimum 12-gauge, galvanized, soft-annealed, mild steel wire.
3. Wire Ties: ASTM A641, 18-gauge, galvanized, annealed steel wire.
4. Furnish manufacturer's hold down clips and accessories required for a complete system in a seismic zone.

2.2 ACOUSTICAL UNITS

A. Recessed Edge Lay-In Panels:

1. Material: Fire-resistive mineral fiber, Class A.
2. Reference Specification: ASTM E1264, Type III, Form 1.
3. Pattern: Fine texture.
4. Noise Reduction Coefficient (NRC): 0.70.
5. Ceiling Attenuation Class (CAC): 35.
6. Light Reflectance: LR 0.80.
7. Nominal Size: 24-inch by 24-inch by 5/8-inch thick.
8. Edges: Tegular, beveled.
9. Finish and Color: Painted white.
10. Manufacturers and Products: Armstrong; Designer Minatone.

PART 3 EXECUTION

3.1 SEQUENCING

A. Lay out grid.

B. Coordinate with mechanical and electrical equipment in framing and cutting material around ceiling penetrations.

C. Install suspension systems after mechanical work above is complete.

D. Install acoustical units.

3.2 INSTALLATION OF SUSPENDED GRID SYSTEM

A. Hang level and in straight alignment directly from structure in accordance with ASTM C636 and the manufacturer's current printed instructions for type of installation required for this project.

B. Hanger Wires:

1. Space maximum 4 feet on center each direction and securely attach to structure above.
2. Install additional hangers at ends of each suspension member and at light fixtures, 6 inches from vertical surfaces.
3. Do not splay wires more than 5 inches in a 4-foot vertical drop.
4. Provide four-way wire splays at 45 degrees from main runner to support structure for every 144 square feet of ceiling area.
5. Wrap wire minimum three times horizontally, turning ends upward.
6. Where hanger wires cannot be hung vertically from structure above because of ducts, pipes, cable trays, or other interferences, provide trapezes of steel channels (minimum 2-inch deep, 16-gauge cold-rolled carrying channels) hung on steel rods or 8-gauge wire from structural members above. Hang ceiling wires from these trapezes or similar members supporting ducts or pipes. Do not hang directly from ducts or pipes.
7. Follow suspension system manufacturer’s instructions for modified installation required in a seismic zone.

C. Edge Molding:

1. Install at intersection of suspended ceiling and vertical surfaces.
2. Miter corners where moldings intersect or install corner caps.
3. Attach to vertical surface with mechanical fasteners.

D. Provide additional channels, hangers, and trapezes as required to support edges of ceiling around and under mechanical and electrical work.

3.3 INSTALLATION OF ACOUSTICAL UNITS

A. Install with pattern running in one direction upon completion of suspended grid system and other concealed work.

B. Place material to bear all around on suspension members.

3.4 CLEANING

A. Clean soiled or discolored unit surfaces after installation.

B. Touch up scratches, abrasions, voids, and other defects in painted surfaces.

3.5 SCHEDULE OF CEILING TYPES

A. Areas to Receive Acoustical Ceilings: Indicated on Interior Finish Schedule on Drawings by SAT.

END OF SECTION

SECTION 09653
RESILIENT FLOORING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM): F1066, Standard Specification for Vinyl Composition Floor Tile.
2. Federal Specifications (FS):
   a. SS-W-40A, Wall Base: Rubber and Vinyl Plastic (Int. Amend. 1, Notice 1).
   b. SS-T-312B, Tile, Floor: Asphalt, Rubber, Vinyl, Vinyl Composition (Int. Amend. 1).

1.2 SUBMITTALS

A. Samples: For color selection.

B. Manufacturer’s literature.

C. Quality Control Submittals: Manufacturer's Certificate of Compliance.

D. Contract Closeout Submittals: List of recommended maintenance products, methods, and procedures.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Unless otherwise directed by COTR/CM, store materials in original containers at not less than 70 degrees F for not less than 24 hours immediately before installation.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature in space to receive flooring between 70 and 90 degrees F for not less than 24 hours before and 48 hours after installation.

B. Maintain minimum temperature of 55 degrees F after flooring is installed, except as specified above.

1.5 SEQUENCING AND SCHEDULING

A. Do not install floor coverings until concrete slab has cured for 60 days or until primer material in test patches cannot be scraped or peeled from the slab after drying 24 hours.

1.6 EXTRA MATERIALS

A. Furnish additional floor covering materials from same production run as installed material at the rate of 45 square feet for each 1,000 square feet.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Flooring products of the following manufacturers meeting these Specifications may be used on this Project:

1. Armstrong World Industries, Inc.
2. Azrock Floor Products.

2.2 FLOOR COVERING MATERIALS

A. Vinyl Composition Tile (VCT):

1. ASTM F1066, Composition 1, Class 2, through pattern tiles.
2. Size: 12- by 12-inch by 1/8-inch thick.
3. Manufacturers and Products: Azrock.
4. Locations and Colors:
   a. Field Tile: Azrock; VL-126, Classic Blue.
   b. Border and accent tiles: Azrock; V-849, Postal Grey.

B. Rubber Base: Federal Specification SS-W-40, Type I, 0.125-inch thick, coved style, 4 inches high, Armstrong Gunmetal No. 93.

C. Trim and Reducers: Standard rubber or vinyl floor reducer in thickness to suit abutting floor covering by 1-inch wide, tapered or beveled-edge strip; colors to match abutting floor covering.

D. Adhesive: Type and brands of adhesive as recommended by manufacturer of covering material for conditions of installation.

E. Primer and Crack Filler: Type and brand recommended by floor covering manufacturer.

F. Wax: Furnish wax, cleaner, or other finishing material as recommended by floor covering manufacturer for the particular type of flooring material.

G. Floor Filler: Asphalt mastic as manufactured by Armstrong, Lancaster, PA, or National Floor Products Co., Florence, AL.

2.3 STAIR COVERING MATERIALS

A. General: Federal Specification ZZ-T-001237, Type I, Class 2, Style A, uniform thickness, in lengths as long as practical for conditions of installation to provide for minimum joints.

B. Threads and Landings: Rubber, 1/8-inch thick, full width by tread depth, nonslip style with square nose; matching material for landings.

C. Risers: Rubber, 1/8-inch thick, top-set cove style, height of riser by full width.

D. Stringers: Rubber, 4 inches high above line of nosings, 1/8-inch thick.

E. Open Edge: Rubber angle trim to match treads.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrate for excessive moisture content and unevenness preventing execution and quality of resilient flooring as specified.

B. Correct defects before installation of resilient flooring.

3.2 PREPARATION

A. Remove dirt, oil, grease, or other foreign matter from surfaces to receive floor covering materials.

B. Fill cracks less than 1/16-inch wide and depression less than 1/8-inch deep with floor filler.

C. Prime sanded wood surfaces with one brush coat of primer.

D. Prime surfaces other than wood if recommended by floor covering manufacturer.

3.3 INSTALLATION OF TILE MATERIALS

A. Mix and apply adhesives in accordance with manufacturer's instructions.

B. Lay tile to center of room or space. Work toward perimeter.

C. Do not lay tile less than half the width of a field tile except where accepted by COTR/CM for irregularly shaped rooms or spaces. Cut border tile neatly and accurately to fit within 1/64-inch of abutting surfaces.

D. Fit flooring material neatly and tightly into breaks and recesses, again bases, around pipes and penetrations, under saddles or thresholds, and around permanent cabinets and equipment.

E. Lay tile parallel to room axis in straight courses with cross joints parallel. Lay tile with grain or pattern running in opposite direction between adjacent tile.

3.4 INSTALLATION OF BASE

A. Remove defects in wall and floor that would prevent level and true installation of base material.

B. Install base around perimeter of room or space, where shown, and at toe spaces of casework and cabinets.

C. Unroll base material and cut into accurate lengths as desired or as required for minimum number of joints.

D. Match edges of seams or double cut adjoining lengths to give continuous appearance.

E. Install with tight butt joints with no joint widths greater than 1/64-inch.

F. Apply adhesive and firmly adhere to wall surfaces.

G. Press down so bottom cove edge follows floor profile.

H. Ensure top and bottom edges of base are in firm contact with walls and floors.

I. Form internal and external corners by using premolded corners. Other methods, acceptable to COTR/CM, may be used if premolded corners are not available.

J. Scribe base accurately to abutting materials.

3.5 INSTALLATION OF STAIR COVERING

A. Cut each piece of covering material to lengths as required. Allow to flatten prior to installation. Match grain and color between adjacent pieces. Install with tight butt joints with no joint width greater than 1/64 inch.

B. For treads and landings apply adhesive and securely adhere tread material to substrate. Finish flush with nosing where separate nosings are required.

C. Set riser after tread material. Apply adhesive and securely bond riser material to substrate. Roll for firm bond. Work out wrinkles and air pockets.

D. Apply stringer material in lengths as long as practical with minimum joints. Cut to accurate shapes for stair profiles. Apply adhesive and securely adhere to substrates in same manner as specified for top-set base materials.

3.6 INSTALLATION OF TRIM MATERIALS

A. Provide where flooring covering terminates exposing edge of covering.

B. Center reducer under door, where floor covering terminates at a door opening. Fit end edges to door frames and abutting surfaces and other edges to adjoining materials.

C. Apply adhesives and bond securely to substrates in straight true lines. Meet visible and related features of building construction with a maximum deviation of 1/8-inch in 10 feet.

3.7 CLEANING AND PROTECTION

A. Upon completion of the installation of floor covering and adjacent work, and after materials have set, clean surfaces with a neutral cleaner as recommended by manufacturer for type of floor covering material installed.

B. Repair adjacent surfaces damaged by flooring installation.

C. Apply one coat of nonslip wax or other finish as recommended by floor covering manufacturer; buff to a sheen.

D. Protect completed work from traffic and damage until Substantial Completion by covering with plastic sheet, kraft paper, or plywood panels.

3.8 INSTALLATION SCHEDULE

A. Areas to receive resilient flooring and rubber base are indicated in the Interior Finish Schedule on the Drawings.

END OF SECTION

SECTION 09680
CARPET

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   b. E648, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

1.2 SUBMITTALS

A. Shop Drawings:

1. Installation drawings showing details of carpet installation, seam locations, pattern, color, carpet to be used, and other pertinent details as may be required.
2. Complete list of other materials proposed.
3. Complete carpet specifications indicating conformance with requirements herein.

B. Samples for color selection.

C. Quality Assurance Submittals:

1. Manufacturer's Statement of Qualification that the carpeting installer is approved by manufacturer to install the carpeting materials.
2. Certificates: Test certificates for flammability that show that the carpet and adhesives have the flame spread rating specified.
3. Manufacturer's installation instructions.
4. Two copies of a list of recommended maintenance products and recommended maintenance methods and procedures.
5. Three copies of manufacturer's maintenance manual for specified carpet.

1.3 PROJECT CONDITIONS

A. Do not begin carpet installation until work of other trades, including painting, has been completed.

B. Do not install floor covering until concrete slab has cured for 60 days or until primer material in test patches cannot be scraped or peeled from the slab after drying for 24 hours.

C. Maintain ambient temperature, in space to receive carpet, of 70 degrees F for not less than 24 hours before and 48 hours after installation.

1.4 EXTRA MATERIAL

A. Furnish additional carpeting materials from same production run as materials installed for future maintenance at the rate of 45 square feet for each 500 square feet up to a maximum of 100 square feet.

1.5 QUALITY ASSURANCE

A. Installer: Experienced in the installation of carpet floor covering, approved by manufacturer, employing only experienced personnel, and familiar with manufacturer's recommendations for installation of materials, and acceptable to the COTR/CM.

B. Dimensions shown on Drawings are approximate. Verify measurements and other conditions of the job.

C. Order ample yardage as no substitutions will be permitted to make up for shortage of material.

D. Carpet of the same type in contiguous areas shall be of the same dye lot.

E. Conform to applicable A.D.A. requirements.

1.6 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of Work specified in this Specification section found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

B. Conditions:

1. Delamination: Not occur to the backing.
2. Wear: No more than 10 percent face fiber loss.

PART 2 PRODUCTS

2.1 CARPET MANUFACTURERS

A. Lees Carpets, Div. Burlington Industries, King of Prussia, PA.

2.2 CARPET

A. Type: Lees, Artstone II, DX936, Color 408 Stonewashed.

B. Face Yarn: 100% Dupont Antron Legacy nylon with Dura Tech Soil Protection.

C. Wear Warranty: 10 years.

2.3 ANCILLARY MATERIALS

A. Seaming Tape: As recommended by carpet manufacturer.

B. Trim:

1. Vinyl, color to match base material.
2. Manufacturers and Products:
   a. Johsonite; Edge Guard, EG-XX-H.
   b. Mercer Products Co., Inc.; Vinyl No. 8 (800) Imperial Reducer.

C. Adhesive: Synthetic rubber, resin blend, as recommended by carpet manufacturer.

D. Tackless Strip: Commercial strip as recommended by the carpet manufacturer.

E. Floor Filler:

1. Asphalt mastic.
2. Manufacturers:
   a. Armstrong, Lancaster, PA.
   b. National Floor Products Co., Florence, AL.

F. Concrete Underlayment, Manufacturer and Product:

1. Ardex Inc., Coraopolis, PA; Ardex K-55.
2. Thoro Systems Products; Thoro Underlayment.

PART 3 EXECUTION

3.1 INSPECTION OF SURFACES

A. Examine substrate for excessive moisture content or unevenness.

B. Do not proceed with installation of materials until defects have been corrected.

C. Carefully check dimensions and other conditions in the field and properly fit carpet in areas indicated.

3.2 PREPARATION

A. Level floors having depressions, cracks, or expansion joints, with floor filler or concrete underlayment.

B. Remove foreign matter, grease, paint, oil, and plaster droppings.

C. Clean floors thoroughly, leaving them dry and structurally firm.

3.3 SEAMING

A. Double cut carpet at seams, straight and true.

B. Seal cut edges.

C. Set iron on medium heat and move at a speed that will produce a complete melt of the tape adhesive.

D. Follow seaming tape manufacturer's instructions and recommendations.

E. Lay out carpet with the fewest possible seams. Run seams parallel with the main source of traffic. No parallel seams will be allowed in front of doorways.

3.4 APPLICATION OF ADHESIVES

A. Mix and apply adhesives in accordance with manufacturer's instruction.

B. Apply uniformly over surfaces:

1. Cover only that amount of area that can be covered by carpet within the recommended working time of the adhesive.
2. Remove adhesive that dries or films over.
3. Do not soil walls, bases, or adjacent areas with adhesives.
4. Promptly remove spillage.

C. Apply adhesives with notched trowel or other suitable tool.

D. Clean trowel and rework notches as necessary to ensure proper application of adhesive.

3.5 INSTALLATION OF GLUED DOWN CARPETING

A. Install carpet in strict conformance with the manufacturer's instructions and recommendations. Do not damage walls or other adjacent work.

B. Run carpeting lengthwise with the long dimension of spaces. Stretch, as required, to a true and even surface and secure to the subfloor with adhesive. Minimize seams in accordance with installer's Seaming Diagram and make as invisible as reasonably possible.

3.6 INSTALLATION OF TRIM MATERIALS

A. Provide where carpet terminates, exposing edge.

B. Center reducer under door, where carpeting terminates at a door opening. Fit end edges to door frames and abutting surfaces and other edges to adjoining materials.

C. Apply adhesives and bond trim securely to substrates in straight true lines. Meet visible and related features of building construction with a maximum deviation of 1/8-inch in 10 feet.

3.7 CLEANING AND PROTECTION

A. Immediately after completion of the floor, remove spots or smears of adhesive and seam cement from floor surface and other finished Work with cleaner or solvent recommended by carpeting materials manufacturer.

B. Repair adjacent surfaces damaged by carpet installation.

C. Thoroughly vacuum clean carpet after installation is complete.

D. Protect completed Work from traffic and damage until Substantial Completion by covering with plastic sheeting, kraft paper, and plywood panels.

3.8 INSTALLATION SCHEDULE

A. Areas to receive carpeting and carpet pattern are indicated with “CARPET” in the Interior Finish Schedule on Drawings.

END OF SECTION

SECTION 09900
PAINTING

PART 1 GENERAL

1.1 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness.
5. MDFTPC: Minimum Dry Film Thickness Per Coat.
6. Mil: Thousandth of an inch.
7. Military Specification-Paint.
8. PSDS: Paint System Data Sheet.
9. SFPG: Square Feet Per Gallon.
10. SFPGPC: Square Feet Per Gallon Per Coat.
11. SP: Surface Preparation.
12. Existing: Those coated surfaces that are cut into, connected to, or otherwise changed or affected by the work of this contract.

B. Paint Terms: Conform to ASTM D16.

1.2 SUBMITTALS

A. Product Data: Manufacturer's descriptive literature for coating materials and coating application accessories.

1. For each paint system used, furnish a Paint System Data Sheet (PSDS) and technical data sheet for each product used in the paint system. PSDS form is appended to the end of this section.
2. Submit required information on a system by system basis.
3. Provide copies of paint system submittals to applicator.
4. Color charts.

B. Quality Control Submittals:

1. List of references substantiating applicator’s experience.
2. Manufacturer's printed application instructions for each product, including product storage requirements and surface preparation requirements.

1.3 QUALITY ASSURANCE

A. Applicator's Experience: Minimum 5 years' practical experience in application of specified products and approved by the paint manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products of this Section in manufacturer's unopened packaging until installation.

B. Establish and maintain storage area conditions for products of this Section in accordance with manufacturer's instructions until installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction over project.

1.5 PROJECT CONDITIONS

A. Do not apply coatings to exterior surfaces except under environmental conditions recommended by coating manufacturer.

B. Establish and maintain environmental conditions recommended by coating manufacturer before, during, and after application of coatings to interior surfaces.

C. During application of coating materials, post "WET PAINT" signs.

D. During application of solvent-based materials, post "NO SMOKING" signs.

1.6 SEQUENCING

A. Do not allow application of finish coats in an area until moisture-producing construction activities, dust-producing construction activities, and other construction activities which could impair performance or appearance of finish coatings, have been completed in that area.

1.7 MAINTENANCE

A. Extra Materials: Supply for each finish coating material, color, and finish specified 2 gallons (7.75L) of paint material, in sealed 1-gallon (3.875L) containers, marked with color and finish identification.

B. Custom Colors: Provide details of color formulae and product availability.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Manufacturer: Products of the following manufacturer, meeting these specifications, shall be used on this project:

1. Benjamin Moore Paint Company, San Francisco, CA.

B. Unless otherwise specified for an individual product or material, supply products specified in this section from the same manufacturer.

2.2 MATERIALS

A. General:

1. Unless otherwise indicated, furnish factory-mixed paints. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not dilute or thin paints, except as instructed.
2. Do not add additives, except as instructed or recommended by paint manufacturer.
3. Furnish each coating material in quantity required for this section from a single production run.
4. Colors: Scheduled herein or to be selected by CONTRACTING OFFICER from manufacturer's full range of available colors.

B. Paint Application Accessories: As specified in this section or as recommended by paint manufacturer's application instructions, including but not limited to thinners, sealers, primers, cleaning agents, etching agents, cleaning cloths, sanding materials, and clean-up materials.

PART 3 EXECUTION

3.1 EXAMINATION

A. Immediately prior to coating application, ensure that surfaces to receive coatings are dry.

B. Ensure that moisture-retaining substrates to receive coatings have moisture content within tolerances allowed by coating manufacturer, using moisture measurement techniques recommended by coating manufacturer.

C. Immediately prior to coating application, examine surfaces to receive coatings for surface imperfections and for contaminants which could impair performance or appearance of coatings, including but not limited to, loose primer, rust, scale, oil, grease, mildew, algae, or fungus, stains or marks, cracks, indentations, or abrasions.

D. Correct the above conditions and other conditions that could impair performance or appearance of coatings in accordance with specified surface preparation procedures before proceeding with coating application.

3.2 PREPARATION

A. Do not start work until surfaces to be finished are in proper condition to produce finished surfaces of uniform, satisfactory appearance.

B. Stains and Marks: Remove completely, if possible, using materials and methods recommended by coating manufacturer; cover stains and marks which cannot be completely removed with isolating primer or sealer recommended by coating manufacturer to prevent bleed-through.

C. Mildew, Algae, and Fungus: Remove, using materials and methods recommended by coating manufacturer.

D. Remove dust and loose particulate matter from surfaces to receive coatings immediately prior to coating application.

E. Remove or protect hardware, electrical plates, mechanical grilles and louvers, lighting fixture trim, and other items not indicated to receive coatings that are adjacent to surfaces to receive coatings.

F. Existing Painted Surfaces: Remove loose and peeling paint. Degloss surface if recommended by manufacturer. Sand smooth. Clean entire surface prior to painting.

G. Aluminum Surfaces: Remove surface contamination by steam or high pressure water. Remove oxidation by phosphoric acid-water solution etching and solvent washing. Apply specified primer as soon as cleaned surfaces are dry.

H. Concrete and Concrete Masonry: Clean surfaces free of loose particles, sand, efflorescence, laitance, form oil, curing compounds, and other substances which could impair coating performance or appearance.

I. Concrete Floors: Remove contaminants which could impair coating performance or appearance, acid-etch, flush with clean water; verify alkaline-acid balance recommended by coating manufacturer; mechanically abrade surface, if required, to achieve medium-sandpaper texture.

J. Galvanized Surfaces: Remove surface contamination and oils by solvent cleaning (SSPC-SP1) and allow to dry. Apply Galvanized Metal Primer in accordance with manufacturer instructions.

K. Wood:

1. Seal knots, pitch streaks, and sap areas with sealer recommended by coating manufacturer; fill nail recesses and cracks with filler recommended by coating manufacturer; sand surfaces smooth.
2. Apply primer coat to back of wood trim and paneling.

L. Gypsum Board: Repair cracks, holes, indentations, and other surface defects using joint compound to produce surface flush with adjacent undamaged surface; sand to produce uniform flat surface when dry.

M. Gypsum Plaster: Cut out cracks, holes, indentations, and other surface defects to extent required for bonding adhesion; apply patching plaster or joint compound to produce surface flush with adjacent undamaged surface; sand to produce uniform flat surface when dry; allow to cure 30 days before coating application.

N. Wood and Metal Doors: Seal top and bottom edges with specified primer.

O. Uncoated Steel and Iron Surfaces: Remove grease, rust, scale, and dust from steel and iron surfaces in accordance with Solvent Cleaning SSPC-SP1. Where heavy coatings of scale or contaminants are evident, clean in accordance with Hand Tool Cleaning SSPC-SP2 or other approved SSPC-SP method as needed.

P. Shop Primed Steel Surfaces: Remove loose primer and dust. Sand and feather edges to smooth surface. Clean areas with solvent and spot prime bare metal surfaces with appropriate primer recommended by manufacturer.

3.3 APPLICATION

A. Apply paint where indicated in Interior Finish Schedule.

B. Apply each coat to uniform coating thickness following manufacturer's instructions, not exceeding manufacturer's specified maximum spread rate for indicated surface; thins, brush marks, roller marks, orange-peel, or other application imperfections are not permitted.

C. For opaque finishes, tint each coat, including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.

D. Allow manufacturer's specified drying time, and ensure correct coating adhesion, for each coat before applying next coat.

E. Inspect each coat before applying next coat; touch-up surface imperfections with coating material, feathering, and sanding if required; touch-up areas to achieve flat, uniform surface without surface defects visible from 5 feet (1.5 m).

F. Do not apply succeeding coat until previous coat has been approved by COTR/CM; only COTR/CM-approved coats will be considered in determining number of coats applied.

G. Remove dust and other foreign materials from substrate immediately prior to applying each coat.

H. Where coating application abuts other materials or other coating color, terminate coating, making clean sharp termination line without coating overlap.

I. Where color changes occur between adjoining spaces, through framed openings that are of same color as adjoining surfaces, change color at outside stop corner nearest to face of closed door.

J. Re-prepare and recoat unsatisfactory finishes; refinish entire area to corners or other natural terminations.

3.4 ITEMS NOT TO BE PAINTED

A. Do not paint the following:

1. Items specified or provided with factory finish.
2. Items indicated to receive other finishes.
3. Items indicated to remain unfinished.
4. Brick, precast concrete, integrally colored plaster.
5. Stainless steel, anodized aluminum, bronze, terne, or lead.
6. Equipment nameplates, fire rating labels, and operating parts of equipment.
7. Acoustical materials.
8. Concealed piping, ductwork, and conduit.

B. Materials and products having factory-applied primer are not considered factory finished.

3.5 PAINT SYSTEMS

A. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
Solvent Clean (SP1)	Wash Primer	1 coat, 0.4 MDFT
	Bituminous Paint	1 coat, 10 MDFT

B. System No. 105 Wood, Varnished (Interior or Exterior):

Surface Prep.	Paint Material	Min. Coats, Cover
Wood	Sanding Sealer	1 coat, 450 SFPG
Lightly Hand Sand	Varnish (Satin)	2 coats, 1.3 MDFTPC

C. System No. 107 Ferrous Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 6) -OR- Pickle (SP 8)	Rust-Inhibitive Primer	1 coat, 3 MDFT
	Alkyd Semigloss	2 coats, 1.7 MDFTPC

D. System No. 109 Concrete Masonry, Low Sheen:

Surface Prep.	Paint Material	Min. Coats, Cover
Masonry	Block Filler	1 coat, 75 SFPG
	Acrylic Low Sheen	2 coats, 1.6 MDFTPC

E. System No. 115 Gypsum Board and Plaster, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
Gypsum Board or Plaster	Latex Primer/Sealer	1 coat, 3.0 MDFT
	Acrylic Low Sheen	2 coats, 1.3 MDFTPC

3.6 PAINT COLOR SCHEDULE

	Manufacturer	Number	Color	Location
PT-1	Benjamin Moore	Ready Mix	White Dove	General (except where noted otherwise)
PT-2	Benjamin Moore	1484	Light Grey	Restrooms
PT-3	Benjamin Moore	778	Blue	Accent Color—one (each): Wall in Break Room, Conference Rooms, Wall at sink in Men's Room
PT-4	Benjamin Moore	756	Green	Accent Wall at Women's Room
PT-5	Benjamin Moore	1435	Plum	Accent
PT-6	Benjamin Moore	Ceiling White	Ceiling White	General
PT-7	Benjamin Moore	1624	Dark Grey	Hollow Metal Door Frames

3.7 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.

1. Paint System Data Sheet.

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PSDS for each coating system.

Paint System Number (from Spec.):
Paint System Title (from Spec.):
Coating Supplier:
Representative:
Surface Preparation:

Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats, Coverage

SECTION 10200
LOUVERS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Movement and Control Association (AMCA): Standard 500.
2. The Aluminum Association Incorporated (AA): Designation system for aluminum finishes.
3. American Society for Testing and Materials (ASTM): D1187, Asphalt-Base Emulsions for Use as Protective Coatings for Metal, Spec.

1.2 SUBMITTALS

A. Shop Drawings: Large scale details of louvers, anchorage, and relationship to adjoining construction.

1. Manufacturer's Literature:
   a. Descriptive and performance data of louvers, including standard drawings and louver-free area.
   b. Parts list, if applicable.
   c. Installation instructions.
   d. Maintenance procedures.

B. Quality Control Submittals:

1. Factory test data.
2. Certificates of AMCA ratings.

PART 2 PRODUCTS

2.1 GENERAL

A. Nonacoustical louver sizes are based on 50 percent free area and 800 fpm maximum velocity through the free area. If louvers furnished do not meet these parameters, CONTRACTOR is responsible for resizing louvers and wall openings and for making all other adjustments to allow for larger openings.

B. Water Penetration Rate: No greater than 0.02 ounces per square foot.

C. Louvers: Rated and tested in accordance with AMCA Standard 500.

D. Furnish louvers with interior duct collars.

2.2 FIXED DRAINABLE LOUVER

A. Frame: Extruded aluminum channel, 0.081-inch thick, 4 inches deep, with interior duct collar and concealed mullions.

B. Blades: Extruded aluminum, 0.081-inch minimum thickness, 35- to 45-degree pitch angles, with integral front drain gutter, spaced 3 to 4 inches on center.

C. Pressure Loss: AMCA certified rating of no greater than 0.10-inch WC.

D. Sizes: On Drawings.

E. Screen: Inside mounted, painted aluminum, 1/2-inch mesh.

F. Finish:

1. Meet the requirements of AA-M12C22A42.
2. Color: Dark bronze anodized.

G. Manufacturers and Products:

1. Construction Specialties; Model 4157.
2. Dowco; Series DBE-4.
3. Ruskin; Model ELF-375DD.

2.3 ACCESSORIES

A. Anchors and Fasteners for All Louvers: Stainless steel.

B. Flashings: Match louver frame.

C. Isolation Tape: Tremco 440, 3M EC1202, or Presstite 579.6.

D. Isolation Paint: ASTM D1187, bituminous coating.

2.4 SOURCE QUALITY CONTROL

A. Factory Performance Tests:

1. Airflow versus pressure loss.
2. Rain penetration data.
3. Air infiltration leakage through closed operating louvers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Check openings to assure that dimensions conform to Drawings.

B. Assure that openings are free of irregularities that would interfere with installation.

C. Do not install louvers until defects have been corrected.

3.2 INSTALLATION

A. Install louvers as shown on reviewed Shop Drawings. Coordinate with heating or ventilation ductwork to be connected.

B. Follow procedures in manufacturer's recommended installation instructions.

C. Installed Louvers: Capable of resisting a wind load of 30 pounds per square foot.

D. Separate aluminum from other metals with isolation tape or paint.

3.3 ADJUSTING AND CLEANING

A. Set adjustable louver blades for uniform alignment in OPEN and CLOSED positions.

B. Adjust louvers so moving parts operate smoothly.

3.4 LOUVER CHARACTERISTICS

A. Provide louvers and vents as shown on Drawings.

END OF SECTION

SECTION 10400
IDENTIFYING DEVICES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI): A117.1, Buildings and Facilities-Accessibility and Usability for Physically Handicapped People.

1.2 SUBMITTALS

A. Shop Drawings:

1. Drawings showing layouts, actual letter sizes and styles, and project-specific mounting details.
2. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.

B. Quality Control Submittals: Manufacturer's installation instructions.

PART 2 PRODUCTS

2.1 DOOR NAMEPLATES

A. Signage package shall meet the requirements of the Americans with Disabilities Act—1990 Accessibility Guidelines for Buildings and Facilities and ANSI A117.1, 1992.

B. Background color: Lead.

C. Letters and numbers shall be as follows:

1. Room numbers shall be 1-1/2 inches high, B-Helvetica, color pearl.
2. Lettering for room usage shall be 7/16 inch high on three 1-inch by 9-inch insert strips, Helvetica Regular, color pearl.
3. Lettering for restroom identification shall be 1 inch high, corresponding symbols shall be 5 inches high.

D. Letters and numbers shall be left justified on sign.

E. Grade 2 Braille shall be placed directly below room numbers.

F. Sign Size:

1. Restroom signs shall be 6 inches by 8-1/2 inches.
2. Room identification signs shall be 9 inches wide.

G. Manufacturer and Model:

1. ASI Sign Systems, St. Louis, MO.; WS-2 with ADA Header 2.

H. Service Disconnect Sign:

1. Provide a permanent, wall-mounted safety sign at service disconnect locations in Room #115 of the FTU addition, and in the Electrical Room of the existing Flight Simulator Training Facility. Signs shall list all other services, feeders, and branch circuits supplying the structure and the area served by each in accordance with NEC 230-2(b). Submit Service Disconnect Sign material, text, installation instructions and locations for approval.

PART 3 EXECUTION

3.1 INSTALLATION-GENERAL

A. In accordance with manufacturer's recommendations.

B. Mount securely, plumb, and level.

C. Final text to be determined by the CONTRACTING OFFICER.

3.2 DOOR NAMEPLATES AND PICTORIAL SYMBOLS

A. Attach to doors or walls adjacent to doors with double-sided foam tape. See Door Schedule on Drawings for room names.

B. Mount with bottom of nameplate at 5 feet 6 inches above floor.

C. Provide pictorial symbols for each sex and handicap-equipped at bathrooms.

D. Service Sign Disconnect:

1. Install signs at service disconnect locations in Room #115 of the FTU addition, and in the Electrical Room of the existing Flight Simulator Training Facility.

END OF SECTION

SECTION 10520
PORTABLE FIRE AND SAFETY EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Fire Protection Association (NFPA): No. 10, Standard for Portable Fire Extinguishers.
2. Underwriters Laboratories Inc. (UL): Fire Protection Equipment List.

1.2 SUBMITTALS

A. Shop Drawings: Manufacturer's product data for each item including sizes, ratings, UL listings, or other certifications, and mounting information.

PART 2 PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

A. General:

1. Conform to NFPA 10 for fire extinguishers.
2. Furnish fire extinguishers and cabinets from one manufacturer.
3. All Extinguishers: UL listed, charged and ready for service.

B. Multipurpose Hand Extinguisher (F. Ext.):

1. Tri-class dry chemical extinguishing agent.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.
6. Minimum UL Rating: 4A-60B:C, 10-pound capacity.

2.2 RECESSED EXTINGUISHER CABINET

A. Body: Stainless steel, 18-gauge, 18-8 alloy, No. 4 finish, recessed type, with break-glass door.

B. Manufacturers and Projects:

1. J.L. Industries; Cosmopolitan 2037 G10.
2. Larsen's Manufacturing Co.; Architectural Series Model 2712-RL.
3. Modern Metal Products; Model 104SR-3.

C. Provide cabinets for locations indicated by the suffix “C” on the Drawings.

2.3 ACCESSORIES

A. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.

1. Metal expansion shields for machine screws at concrete and masonry.
2. Stainless steel.

B. Brackets: For all hand extinguishers not located in cabinets, furnish heavy-duty brackets with clip-together strap for wall mounting.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install where indicated or directed and following manufacturer's recommendations.

B. Plumb and level equipment.

C. Rigidly attach cabinets and brackets to structure.

D. Provide adequate backing for mounting surfaces.

3.2 PORTABLE FIRE EXTINGUISHERS AND CABINETS

A. Provide at locations shown or as directed by COTR/CM.

B. Mount hangers securely in position, following manufacturer's recommendations.

C. Top of Extinguisher: No more than 54-inches above floor.

END OF SECTION

SECTION 10999
MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Standards for Testing and Materials (ASTM): A591, Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications.

1.2 SUBMITTALS

A. Shop Drawings: Manufacturers' descriptions, installation data, color charts, and cleaning and service instructions for all items proposed for use. Clearly identify each item.

PART 2 PRODUCTS

2.1 WRITING BOARD (WB)

A. Materials: Stretcher level sheet steel facing, 28-gauge minimum; plywood, particle, or hard board; anodized extruded aluminum frame and tray.

B. Composition: Face sheet bonderized and surfaced to accept watercolor and semi-permanent writing inks with selective erasability; Class 1 Fire Hazard Classification with flame spread of 25 or less when tested in accordance with ASTM E84; bonded to plywood, hard, or particle board backing.

C. Finish and Color: White porcelain enamel semigloss writing surface finish impervious to cracking, checking, chipping, and peeling. Extruded aluminum frame and tray: bronze anodize finish.

D. Size: 8 feet by 4 feet.

E. Accessories: Twelve watercolor markers, six black and six assorted colors compatible with writing surface; cleaners, towels, magnetic strips, and instruction booklet.

F. Manufacturers:

1. Alliancewall Corp.
2. Best-Rite Chalkboard Co.
3. Carolina Chalkboard Co.
4. Claridge Products and Equipment, Inc.
5. Greensteel, Inc.

6. Weber Costello Co.

2.2 TACKBOARD (TB)

A. Materials: Plastic-impregnated cork 1/4-inch thick; 1/4-inch hardboard or plywood backing; extruded aluminum frame.

B. Composition: Cork face sheet, factory cemented to hardboard or plywood backing.

C. Finish and Color: Ground natural cork with washable vinyl finish and integral color throughout. Color and texture of cork surface: natural; bronze anodized finish on extruded aluminum frame.

D. Size: 8 feet by 4 feet.

E. Accessories: Clip angle hangers at 24 inches on center top and bottom.

F. Manufacturers and Products:

1. Greensteel, Inc., Dixonville, PA.; “A” Series.
2. Claridge Products and Equipment, Inc.; Harrison, AR, Series 4, Type CO, with Fabricork No. 1550.

2.3 PROJECTION SCREEN (PS)

A. Materials: Mildew- and flame-resistant glass fiber fabric with vinyl-coated surface; 22-gauge steel case.

B. Composition: Wall mounted, manually operated projection screen enclosed in a steel case.

C. Finish and Color: Matte white projection screen surface; baked white enamel steel case.

D. Size: 72-inch by 72-inch.

E. Manufacturers and Products:

1. Da-Lite Screen Co., Inc., Warsaw, IN; Vidio B.
2. Draper Screen Co., Spiceland, IN; Luma.

2.4 FLOOR MAT AND FRAME

A. Mat and Frame:

1. Manufacturer and Product: C/S Group, Peditred-Low Profile (Recessed) Tread, Standard Grid Finish M71.
2. Color: Carpet No. 9325 Graphite.

3. Size: As indicated on the Drawings.

2.5 TOILET PARTITION

A. Materials: Steel sheets for baked enamel finish in accordance with ASTM A591, Class C and galvanized-bonderized with core of manufacturer's standard sound-deadening, honeycomb impregnated Kraft paper.

B. Composition: Ceiling-hung, flush metal toilet partitions and doors and wall-hung, bracket supported, flush metal urinal screens where shown on the Drawings. Fabricate of two sheets of galvanized-bonderized stretcher leveled steel, assembled over, and cemented under pressure to a core of sound-deadening insulation and edged with a continuous locking strip.

C. Finish and Color: Baked enamel finish and color shall be 715 Platinum.

D. Size: As indicated on Drawings. Minimum panel as follows:

1. Doors: 1-inch thick; 22-gauge.
2. Partitions and Screens: 1-inch thick; 20-gauge.
3. Pilasters: 1-1/4-inch thick; 20-gauge.
4. Headrails to be 1-inch by 1-1/2-inch by 20-gauge stainless steel.

E. Accessories: Manufacturer's standard hardware and accessories, including a coat hook-bumper and a double-roll toilet tissue dispenser.

F. Manufacturer: Metpar Corp.

2.6 TOILET ROOM ACCESSORIES

A. Furnish accessory items listed where indicated by mark or note on Drawings:

Item	Mark	American Specialties, Inc. (ASI)
Surface Mounted Roll Toilet Paper Dispenser	TPD	No. B-0030
Wall Mounted Liquid Soap Dispenser	SD	No. B-0342
Mirror, Size on Drawings	MIR	No. 0600
Recessed Paper Towel Dispenser and Receptacle	PTD/WR	No. 0469
Napkin Disposal	ND	No. 0473-A
Double Robe Hook	RH	No. 7345
Shower Curtain Rod	SCR	No. 1204
Shower Curtain w/Hooks	SC	No. 1200-SHU & 1200-V

B. Finish: Satin stainless steel finish.

C. Anchors: Furnish anchors, fasteners, or other devices necessary for a complete, secure installation.

2.7 VANITIES AND SHOWER COMPARTMENTS

A. Vanities:

1. Includes: Countertop, supports, front and side skirt, sidesplash and backsplash for a complete vanity system.

B. Shower Compartment:

1. Size: 36 inches by 36 inches by 80 inches.
2. Shower base and shower wall surrounds including molding and soap dish for a complete shower compartment system.

C. Materials:

1. 1/2-inch thick solid polymer resin.
2. Shall not absorb moisture and odor, and mildew resistant.
3. Resistant to marks from pens, pencils and other writing instruments.

D. Manufacturer and Product: Formica Corp. Surrell Silverado.

2.8 LOCKER

A. Materials: Mild cold-rolled and leveled furniture steel, free from buckle, scale and surface imperfections. Cadmium, zinc, or nickel plated steel exposed bolt heads, slotless type; self-locking nuts or lock washers for nuts on moving parts.

B. Composition: Double-tier, single-door, steel locker and standard door with louvers top and bottom.

C. Finish and Color: Baked-on enamel over bonding and rust-resisting phosphate undercoat, in color(s) as selected by the COTR/CM.

D. Size: Fifteen inches wide by 18 inches deep by 72 inches high.

E. Accessories: Sloping top 20-gauge sheet steel, flat bottom for mounting on raised base, combination padlock, single hat shelf with rolled front, and non-corrosive number plates with black numerals, numbered consecutively as shown on Drawings.

F. Manufacturers:

1. The Interior Steel Equipment Co.
2. List Industries, Inc.
3. Republic Storage Systems.

2.9 LOCKER BENCHES

A. Tops:

1. Clear hardwood.
2. 1-1/4 inches thick by size as shown on the Drawings.
3. Three coats plastic sealer finish.

B. Wall Mounted Brackets: Manufacturer's standard wall mounting brackets.

PART 3 EXECUTION

3.1 INSTALLATION OF SPECIALTIES

A. Follow the manufacturer's recommendations and printed instructions. Consult with the COTR/CM so that minor adjustments in the locations can be decided if necessary.

1. Install materials plumb or level as applicable and attach securely to the adjacent materials with suitable fasteners.
2. Prevent scratching or damaging adjacent materials during the installation.

B. Floor Mat and Frame:

1. Securely anchor frame in place following manufacturer's instructions. Place cement grout base 7/16 inch below the floor level, screeded into the interior frame area, using the edge of the frame as a guide.
2. Install mat in frame recess so that it is flat without curls or humps.

C. Toilet Partitions:

1. Erect partitions, screens, and related items in a rigid substantial manner, straight and plumb, and with horizontal lines level.
2. Clearances: At the wall, 1 inch for panels and pilasters; at vertical edge of doors, uniform from top to bottom and not exceeding 3/16 inch. Install doors free of warp and wind.

D. Toilet Room Accessories:

1. Coordinate support framing and backing as necessary for the proper installation of accessories.
2. Locate where shown on Drawings at height indicated. or as recommended by the COTR/CM.

3. Following manufacturer's instructions and recommendations, install and securely anchor accessories in their proper locations.
4. Remove protective maskings and clean surfaces, leaving them free of soil and imperfections.
5. Fill units with necessary supplies before Substantial Completion of Work.

END OF SECTION

SECTION 12500
WINDOW TREATMENT

PART 1 GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Details of installation indicating size, attachments, and clearances of operating hardware with other construction.

B. Quality Control Submittals: Manufacturer's written instructions for the care, repair, and cleaning of all components provided in the Work. Include a detailed list of hardware parts identified by manufacturer's catalog numbers and diagrams of installation methods. Include color selection chart.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:

1. Experienced and regularly engaged in the installation of window blinds and draperies.
2. Use proper facilities and methods for production of the Work.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Do not deliver drapes until ready for installation.
2. Handle in accordance with manufacturer's instructions.

B. Storage and Protection: Store blinds and accessories in unopened packages in manner to prevent damage from environmental and construction operations.

1.4 SPECIAL GUARANTEE

A. Furnish manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of Work specified in this Specification section found defective during a period of 3 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Horizontal Blinds: Aluminum horizontal slats 1-inch wide supported by braided ladders and hardware enclosed in a metal head.

1. Manufacturer and Product:
   a. Levolor Lorentzen, Inc., Lyndhurst, NJ 07071; Riviera 1-inch blind.
2. Slats: 5000 Series magnesium aluminum alloy, 1-inch wide, unperforated.
3. Color: 887 Raw Umber.
4. Headrail: 1-inch high by 1-9/16-inch wide, U-shaped, color to match slats.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements of openings to receive blinds, and provide systems in coordination with work of other trades. Delay installation until all other finish Work in spaces is complete.

3.2 BLIND INSTALLATION

A. Install the hardware to manufacturer's recommendations as approved for conditions of the installation. Install in accurate locations, make plumb, true to line, complete with accessories required for satisfactory operations, attach to building construction using approved type of fasteners so as to be rigid and secure, taking care to prevent cracking, marring, or other damage to adjacent finished surfaces.

3.3 ADJUSTING

A. After installation, test and adjust each unit.

3.4 CLEANING

A. Leave installation in a clean and dust-free condition.

3.5 INSTALLATION SCHEDULE

A. Install blinds at the following locations:

1. All interior windows or relights.
2. All exterior windows.
3. All door frame sidelights for Type F-3 and F-4 frames.

END OF SECTION

SECTION 13930
FIRE SUPPRESSION SPRINKLER SYSTEM

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. National Fire Protection Association (NFPA):
   a. 13, Standard for the Installation of Sprinkler Systems.

1.2 DESIGN REQUIREMENTS

A. General:

1. Design the fire suppression sprinkler system in accordance with the requirements of this Section.
2. Coordinate the design of the fire suppression sprinkler system with the authorities having jurisdiction in the Project locality. Obtain required permits and arrange for inspections required by such permit.
3. Coordinate fire suppression sprinkler system routing with building structure, other piping, ductwork, and electrical.
4. Verify and incorporate into the design the actual water pressure and available water flow for the fire suppression sprinkler system.
5. Sprinkler Heads:
   a. Locate at quarter points in ceiling tile centered one way.
6. Piping:
   a. Three-inches Diameter and Smaller: For use in areas above slabs and inside buildings shall be black steel.
   b. Four-inches diameter and larger: Black steel or cement-lined ductile iron.
   c. Underground Applications: Cement-lined ductile iron.
7. Valves: As specified in Section 15100, VALVES AND OPERATORS
   a. System Control:
      1) 2 Inches and Smaller: Type V140.
      2) 2-1/2 Inches and Larger: Type V142.
   b. System Drain and Test (2 Inches and Smaller):
      1) Globe, Type V200.
      2) Angle, Type V201.
   c. Fire Department Connection Valve: Check with ball drip, Type 610.
8. This project is an extension to the existing Flight Simulator Building. The valve sprinkler valve room is located in the existing building. The new sprinkler zone valves for the new building extension shall be

located in the Flight Simulator Building valve room. Hydraulic calculation shall be done on the entire (new and existing) buildings.

B. Automatic Wet Pipe System:

1. With exception of electrical rooms, protect entire facility by an automatic wet pipe system.
2. Hazard Occupancy: Ordinary, Group 1.
3. Hydraulic Operation Area: 1,500 square feet at an area/density rating of 0.15 gpm per square foot.
4. Floor control valves assemblies at each floor level, each riser. Supervise floor control valves to alarm on closure. Pipe floor control valve drains to building drainage system.
5. Design sprinkler system to interface with Section 16720, FIRE ALARM SYSTEM.

C. Automatic Dry Pipe System:

1. Design for the following areas:
   a. Boom Operator Part Time Trainer (BOPTT)
2. Hazard Occupancy: Ordinary, Group 1
3. Hydraulic Operation Area: 1500 square feet at an area/density rating of 0.15 gpm per square foot plus 250 gpm hose stream demand.
4. Design system to interface with Section 16720, FIRE ALARM SYSTEM.

1.3 SUBMITTALS

A. Shop Drawings:

1. Reflected ceiling plans showing sprinkler head locations.
2. Schematic, wiring, and interconnection diagrams of system.
3. Catalog cuts of system components.
4. Design calculations.

B. Quality Control Submittals:

1. Written documentation showing proof of system designer’s and installer’s qualifications.
2. Manufacturer's installation instructions for supervisory switches.
3. Certificate of Compliance: Upon completion of the system installation, verify all fire department hose connections, and check all fire safety devices to ensure their readiness for emergency connection and operation.
4. Manufacturer's Certificate of Proper Installation.

5. Written evidence that required permits have been secured and that inspections and acceptance tests have been satisfactorily performed.
6. Written test reports of each test and inspection.
7. Operation and maintenance manual.

1.4 QUALITY ASSURANCE

A. Qualifications: Design and installation shall be performed by persons with an established reputation in the fire protection industry who can furnish a list of satisfactory installations of the type of system specified.

B. Regulatory Requirements:

1. National Fire Codes.
2. Uniform Fire Code.
3. Requirements of OWNER's insurance underwriter, if applicable.
4. City or State authorities having jurisdiction.

1.5 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage, spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. All equipment shall be Factory Mutual (FM) approved.

2.2 PIPING

A. Black Steel: As specified in Section 15060-03, DS-CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE.

2.3 VALVES

A. Indicating type, with supervisory switches. Supervision shall be in the OPEN position such that closing of valves results in alarm.

2.4 DRY PIPE VALVE ASSEMBLY

A. Assembly shall provide a complete and automatic dry pipe fire sprinkler system.

B. Assembly shall include required trim and pressure gauges, air pressure maintenance device, anti-flood device, accelerator, if required, water pressure actuated alarm switch connected to an electric alarm bell, and any other miscellaneous accessories required by the system served.

C. Air Compressor: Capacity to restore normal air pressure in the system within a 30-minute period.

2.5 SUPERVISORY SWITCH

A. Suitable for either OS&Y gate valve or indicator post.

B. Capable of operating between first and second revolution of valve control wheel or if housing cover is removed.

C. Rating: 5 amps, 120V ac.

D. Manufacturers:

1. Potter.
2. Chemetron.

2.6 FLOW DETECTOR SWITCH

A. Switch shall actuate on flow of water that equals or exceeds the discharge from one sprinkler head.

B. Minimum Rating: 5-amp, 120V ac and 2.5-amp, 24V dc.

C. Pneumatic retard element with an adjustable range of zero to 70 seconds.

D. Two contacts (DPDT) suitable for providing a signal to the local fire alarm bell and light, and remote fire alarm system.

E. Manufacturers:

1. Notifier.
2. Viking.

2.7 SPRINKLER HEAD

A. Temperature Rating: 165 degrees F.

B. Manufacturers:

1. Grinnell.

2. Central Sprinkler Corp.

2.8 PIPE HANGERS AND SUPPORTS

A. In accordance with NFPA 13.

2.9 SWAY BRACING

A. In accordance with NFPA 13, and suitable for Seismic Zone $A_V = 0.05$, $A_E = 0.05$.

2.10 VALVE IDENTIFICATION TAGS

A. In accordance with NFPA 13

2.11 ACCESS DOORS

A. As specified in Section 08300, SPECIAL DOORS.

PART 3 EXECUTION

3.1 VALVES

A. Control Valves: Where more than one control valve is required, provide identification signs indicating portion of the total system controlled by respective valve, on valve, or on wall near valve location as specified in accordance with NFPA 13.

B. System Test and Drain Valves:

1. Where valves are located above ceilings with removable panels, install panels with a nametag that allows readily visible identifying test valve location.
2. Where valves are installed above fixed ceilings, install an access panel, and paint to match ceiling color with identification tag for valve.
3. Install drain valves in portions of system that cannot drain by gravity to main drain valve.

C. Double Check Valve Assembly: Install with test cocks and nameplate accessible from front of unit.

3.2 SUPERVISORY SWITCH

A. Provide on each fire protection system control valve.

B. Install in accordance with manufacturer's instructions and as specified in Section 15100, VALVES AND OPERATORS.

C. Make electrical connections specified in Section 16720, FIRE ALARM SYSTEM.

3.3 SPRINKLER HEAD

A. Provide chrome-plated canopy flanges on pendant sprinkler heads in finished ceilings.

B. Provide brass pendant or upright heads in unfinished areas.

C. Provide guards on sprinkler heads located in areas where heads are subjected to mechanical damage.

D. Spare Heads:

1. Provide in accordance with NFPA 13, mounted in manufacturer's standard metal cabinet.
2. Mount cabinet on wall near fire protection header.

3.4 FLOW DETECTOR SWITCH

A. Do not mount switch in a pipe fitting or within 12 inches of fittings that change direction of waterflow.

B. Electrical connection as specified in Section 16720, FIRE ALARM SYSTEM.

3.5 PIPE HANGERS AND SUPPORTS

A. Spacing, location, and installation in accordance with NFPA 13.

3.6 FIELD FINISHING

A. As specified in Section 09900, PAINTING.

3.7 FIELD QUALITY CONTROL

A. Upon completion of fire protection system, perform acceptance test as required and outlined in NFPA 13.

B. Notify the authority having jurisdiction of acceptance test readiness.

3.8 PERFORMANCE TEST

A. Test in accordance with NFPA 13.

B. Perform under actual or approved simulated operating conditions.

C. Perform with the COTR/CM and authority having jurisdiction present.

END OF SECTION

SECTION 15060
PIPING - GENERAL

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
2. American National Standards Institute (ANSI):
   a. A21.52, Ductile Iron Pipe, Centrifugally Cast, Gas.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   d. B16.3, Malleable Iron Threaded Fittings.
   e. B16.5, Pipe Flanges and Flanged Fittings.
   f. B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
   i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500 and 2500.
   l. B16.25, Butt Welding Ends.
   m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels.
   b. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   c. B31.1, Power Piping.
   d. B31.3, Process Piping.
   e. B31.9, Building Services Piping.
   f. B36.10M, Welded and Seamless Wrought Steel Pipe.
5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.

6. American Society for Testing and Materials (ASTM):
   a. A47, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   d. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   f. A135, Standard Specification for Electric-Resistance-Welded Steel Pipe.
   g. A139, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
   h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   j. A182/A182M, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
   l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both.
   n. A197/A197M, Standard Specification for Cupola Malleable Iron.
   o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
   q. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   r. A276, Standard Specification for Stainless Steel Bars and Shapes.
   s. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   t. A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength.
   u. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

v. A312/A312M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
w. A320/A320M, Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service.
x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
aa. A536, Standard Specification for Ductile Iron Castings.
bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
dd. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
ee. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
ff. B32, Standard Specification for Solder Metal.
gg. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
hh. B61, Standard Specification for Steam or Valve Bronze Castings.
ii. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
jj. B75, Standard Specification for Seamless Copper Tube.
kk. B88, Standard Specification for Seamless Copper Water Tube.
ll. B98/B98M, Standard Specification for Copper-Silicone Alloy Rod, Bar and Shapes.
mm. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
nn. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
oo. D413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
pp. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
qq. D1330, Standard Specification for Rubber Sheet Gaskets.
rr. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
ss. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

tt. D2000, Standard Classification System for Rubber Products in Automotive Applications.
uu. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
vv. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ww. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
xx. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
yy. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
zz. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
aaa. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
bbb. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ccc. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
ddd. D4101, Standard Specification for Propylene Plastic Injection and Extrusion Materials.
eee. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
fff. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
ggg. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
hhh. F491, Standard Specification for Poly(Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings.
iii. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
jjj. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

7. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches for Water and Other Liquids.
   c. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.

f. C153/A21.53, Ductile-Iron Compact Fittings 3 Inches Through 24 Inches and 54 Inches Through 64 Inches, for Water Service.
g. C200, Steel Water Pipe - 6 Inches and Larger.
h. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches and Larger - Shop Applied.
i. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 Inches Through 144 Inches.
j. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
k. C213, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
l. C606, Grooved and Shouldered Type Joints.
m. M11, Steel Pipe - A Guide for Design and Installation.

8. American Welding Society (AWS):
   a. A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   b. QC 1, Standard for AWS Certification of Welding Inspectors.
9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP43, Wrought Stainless Steel Butt-Welding Fittings Including Reference to Other Corrosion Resistant Materials.
10. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.2 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Building Service Piping: ASME B31.9, as applicable.
2. Sanitary Building Drainage and Vent Systems: BOCA Uniform Plumbing Code and Local plumbing code.
3. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO Standard Specifications for Highway Bridges, as applicable.
4. Thrust Restraints:
   a. Design for test pressure shown in Piping Schedule.
   b. Allowable Soil Pressure: 1,000 pounds per square foot.
   c. Low Pressure Pipelines:
      1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
      2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.3 SUBMITTALS

A. Quality Control Submittals:

1. Manufacturer's Certification of Compliance.

1.4 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01600, MATERIAL AND EQUIPMENT, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.1 PIPING

A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.2 JOINTS

A. Grooved End System:

1. Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, furnish flexible type.
2. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. Flanged Joints:

1. Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

C. Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1.

D. Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

E. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with breakoff tightening bolts.
2. Manufacturer and Product: EBAA Iron Inc.; Megalug.

F. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
   a. Pipeline Products Corp.
   b. Fernco Joint Sealer Co.

2.3 THRUST BLOCKS

A. Concrete: As specified in Section 03300, CAST-IN-PLACE CONCRETE.

2.4 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

B. Galvanizing:

1. Hot-dip applied, meeting requirements of ASTM A153.
2. Electroplated zinc or cadmium plating is unacceptable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.2 PREPARATION

A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

B. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions

3.3 INSTALLATION-GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.

D. Threaded and Coupled Joints:

1. Conform with ANSI B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

F. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

G. Ductile Iron, Cement-Lined Ductile Iron, and Glass-Lined Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

3.4 INSTALLATION-EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 15140, PIPING SUPPORT SYSTEMS.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inches, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Head room in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.5 INSTALLATION-BURIED PIPE

A. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 02225, TRENCH BACKFILL.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. After joint has been made, check pipe alignment and grade.
10. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
11. Prevent uplift and floating of pipe prior to backfilling.

B. PVC or CPVC Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

C. Tolerances:

1. Deflection From Horizontal Line, Except PVC or CPVC Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4-inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.6 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist due to hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.

B. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03301, REINFORCED CONCRETE.

3.7 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.8 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations.

3.9 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

C. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

D. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.10 INSULATION

A. See Section 15250, PIPE INSULATION.

3.11 DISINFECTION

A. See Section 02683, DISINFECTION OF W1 WATER SYSTEMS.

3.12 FIELD FINISHING

A. Notify COTR/CM at least 3 days prior to start of any surface preparation or coating application work.

B. As specified in Section 09900, PAINTING.

3.13 PIPE IDENTIFICATION

A. As specified in Section 02320, TRENCH BACKFILL and 09900, PAINTING.

3.14 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 15992, PIPING LEAKAGE TESTING.

3.15 SUPPLEMENTS

A. Piping Schedule.

B. Data Sheets.

Number	Title
-02	Carbon Steel Pipe and Fittings-Special Service
-03	Carbon Steel Pipe and Fittings-General Service
-11	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings
-13	Copper and Copper Alloy Pipe, Tubing, and Fittings
-16	Polyvinyl Chloride Drain, Waste, and Vent (PVC-DWV) Pipe and Fittings

END OF SECTION

PIPING SCHEDULE LEGEND

SERVICE

CD	Condensate Drain
FS	Fire Sprinkler
HW	Potable Hot Water
HWS/R	Heating, Hot Water Supply/Return
G	Natural Gas
SD	Storm Drain
SS	Sanitary Sewer
V	Vents
W1	Water-Potable

EXPOSURE

BUR	Buried
EXP	Exposed

MATERIAL

CISP	Cast Iron Soil Pipe
COP	Copper
CPVC	Chlorinated PVC
DI	Ductile Iron
PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
STL	Steel

PRESSURE TEST

H	Hydrostatic
P	Pneumatic

PIPING SCHEDULE

Service	Size(s) (In.)	Location	Piping Material	Joint/ Type	Operating Pressure (psig)	Test Type	Insulation	Test Pressure (psig)	Color Band/ Lettering	Remarks
CD	3/4 – 2	EXP	PVC	SO	NA	H	HG	15 (ft)	NA	15060-16
FS	1/2 – 6	BUR EXP	STL	SC, FL SW, W	70	H		200	Red/White	15060-03
G	1/2 – 3	EXP BUR	STL	SC SW	20	H		150	Yellow/Black	15060-02
HWS HWR	1/2 – 4	EXP	STL	SC SW	40	H	HG	150	Yellow/Black	15060-03
HW, HWC	1/2 – 3	EXP	COP	SO	20	H	DW	150	Yellow/White	15060-13
SS	3 – 6	BUR EXP	CPVC CISP	---	---	H		100	NA	15060-11 15150
SD	3 – 6	EXP BUR	CISP CPVC	---	---	H		100	NA	15150 15060-11
V	1-1/4 – 4	EXP	PVC- DWV	---	---	H		100	NA	15060-16
W1	1/2 – 3	EXP BUR	COP	SO	70	H	DW	150	Green/White	15060-13 15060-13
Note: All HG temperatures use 201 degrees F to 500 degrees F										

SECTION 15060-02
CARBON STEEL PIPE AND FITTINGS-SPECIAL SERVICE

Item	Size	Description
Pipe		Black carbon steel, ASTM A106, Grade B seamless or ASTM A53 Rev A, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints:
	1-1/2” & smaller	Schedule 80.
	2” thru 10”	Schedule 40, except 4-inch and smaller in chlorine service; Schedule 80.
Joints	2” & smaller	Threaded or socket-welded; flanged at equipment as required or shown.
	2-1/2” & larger	Butt-welded or flanged at valves and equipment.
Fittings	2” & smaller	Threaded, forged carbon steel, ASTM A105/A105M, 2,000- or 3,000-pound WOG, conforming to ANSI B16.11; bore to match pipe inside diameter.
	2-1/2” & larger	Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	2” & smaller	Threadolet or socket in conformance with Fittings above.
	2-1/2” & larger	Butt-welding tee in accordance with Fittings above.
Flanges	2” & smaller	Forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face.
	2-1/2” & larger	Forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings.

SECTION 15060-02 CARBON STEEL PIPE AND FITTINGS-SPECIAL SERVICE		
Unions	2” & smaller	Threaded socket-weld, forged carbon steel, ASTM A105/A105M, 2,000- or 3,000-pound WOG, integral ground steel-to-steel seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Bolting	All	Carbon steel ASTM A193/A193M Rev A, Grade B7 studs and ASTM A194/A194M, Grade 2H hex head nuts. Quench and temper for chlorine service. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts and ASTM A563, Grade A heavy hex nuts.
Gaskets	All flanges	General Service and Oil/Gas: 1/16-inch thick compressed nonasbestos composition flat ring type. Garlock, Style 3000; Manville, Style 978.
Thread Lubricant		General Service: Teflon tape.

END OF SECTION

SECTION 15060-03 CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	All	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53 Rev A, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:
	Screwed:	
	2 inch & smaller	Schedule 80.
	Welded:	
	2-1/2 thru 10 inch	Schedule 40.
	Grooved:	
	2-1/2 thru 6 inch	Schedule 40.
	8 thru 12 inch	Schedule 30.
Joints	2 inch & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606..
	2-1/2 inch & larger	Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.
Fittings	2 inch & smaller	Threaded: 150- or 300-pound malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3. Fire sprinkler fittings to be UL listed. Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation. Victaulic; Grinnell.
	2-1/2 inch & larger	Butt Welded: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation. Victaulic; Grinnell.

SECTION 15060-03 CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE		
Item	**Size**	**Description**
Branch Connections	2 inch & smaller	Threaded, straight, or reducing tees in conformance with Fittings specified above.
	2-1/2 inch & larger	Butt-welding or grooved end tee in conformance with Fittings specified above.
Flanges	2 inch & smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face.
	2-1/2 inch & larger	Butt-Welded Systems: Forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Grooved End Adapter Flange: Malleable iron ASTM A47 or ductile iron ASTM A536. Victaulic; Grinnell. Cast Iron Mating Flange: AWWA C207, Class D or E, hub or ring type, ANSI B16.1, 125-pound drilling, AWWA C207 Class F hub type or ASTM A105/A105M, ANSI B16.5 Class 300-pound, drilling.
Unions	2 inch & smaller	Threaded malleable iron, ASTM A197 or A47, 150- or 300-pound WOG, meeting the requirements of ANSI B16.3.
Couplings	2-1/2 inch & larger	Grooved End: Rigid joint malleable iron, ASTM A47 or ductile iron, ASTM A536. Victaulic; Grinnell. Screwed End: Malleable iron, ASTM A197 or A47.

SECTION 15060-03 CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE		
Item	**Size**	**Description**
Bolting	All	Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts. Use 1/8-inch undersize bolting material for insulating flanges. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength.
Gaskets	All flanges	Water, Steam, and Air Services: 1/16 inch thick, compressed inorganic fiber with nitrile binder, rated to 700 degrees F and 1000 psi. Fuel Gas Service: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 300 degrees F, conforming to ANSI B16.21 and ASTM D1330, Steam Grade. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange. Grooved Couplings: EPDM per ASTM D2000 for water and air to 230 degrees F, nitrile for oil service to 180 degrees F.
Thread Lubricant	2 inch & smaller	General Service: Teflon tape.

END OF SECTION

SECTION 15060-11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 40 or 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441. Threaded nipples shall be schedule 80.
Fittings	All	Schedule 80 CPVC as Specified Under Pipe Above: Conforming to the requirements of ASTM F439 Rev A for socket-weld type and ASTM F437 for threaded type.
Joints	All	Solvent socket-weld except where connection to valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; 125-pound ANSI B16.1 drilling.
Bolting	All	Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 15060-13
COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS

Item	Description
Pipe	Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43.
Tubing	Seamless, conforming to ASTM B88 Rev A as follows: No. 1 water (buried) .....Type K, soft or hard temper No. 1 water (exposed).....Type L, hard drawn Domestic hot water .....Type L, hard drawn Compressed air service .....Type L, hard drawn P-Trap priming service .....Type L, soft temper
Fittings	Commercially pure wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22.
Flanges	Commercially pure wrought copper, socket joint, conforming to ASTM B75, faced and drilled 150-pound ANSI B16.24 standard.
Bolting	ASTM A307, carbon steel, Grade A hex head bolts and ASTM A563 Grade A hex head nuts.
Gaskets	1/16-inch thick non-asbestos compression type, full face, Cranite, Johns-Manville.
Solder	95-5 wire solder (95 percent tin, 5 percent antimony), conforming to ASTM B32 Grade 95TA. Do not use cored solder.

END OF SECTION

SECTION 15060-16
POLYVINYL CHLORIDE
DRAIN WASTE AND VENT (PVC-DWV)
PIPE AND FITTINGS

Item	Size	Description
Pipe and Fittings	All	PVC-DMV Schedule 40 nonpressure application, Class 12454-B conforming to ASTM D2665 and ANSI/NSF Standard 14 system.
Joints	All	Solvent cemented conforming to ASTM D2855 except where connection to equipment may require future removal.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.

END OF SECTION

SECTION 15100
VALVES AND OPERATORS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   b. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
3. American Society for Testing and Materials (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351, Standard Specification for Castings, Austenitic, Austenitic-Ferric (Duplex), for Pressure-Containing Parts.
   c. A564, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
   d. B61, Standard Specification for Steam or Valve Bronze Castings.
   e. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
   f. B98, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
   g. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
   h. B139, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   i. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
   j. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
   k. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   l. D429, Test Methods for Rubber Property—Adhesion to Rigid Substrates.
   m. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
4. American Water Works Association (AWWA):
   a. C500, Metal-Seated Gate Valves for Water Supply Service.
   b. C504, Rubber-Seated Butterfly Valves.

c. C508, Swing-Check Valves for Waterworks Service, 2 in. to 24 in. NPS.
d. C509, Resilient-Seated Gate Valves for Water Supply Service.
e. C510, Double Check Valve, Backflow-Preventer Assembly.
f. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
g. C540, Power-Actuating Devices for Valves and Sluice Gates.
h. C550, Protective Epoxy Interior Coatings for Valves and Hydrants.
i. C606, Grooved and Shouldered Joints.
j. C800, Underground Service Line Valves and Fittings.

5. Manufacturers Standardization Society (MSS):
   a. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
   b. SP-88, Diaphragm Type Valves.

1.2 SUBMITTALS

A. Shop Drawings:

1. Product data sheets for make and model.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Sizing calculations for open-close/throttle and modulating.

B. Quality Control Submittals:

1. Certificate of Compliance for:
   a. Electric operators; full compliance with AWWA C540.
2. Tests and inspection data.
3. Manufacturer's Certificate of Proper Installation.
4. Operation and Maintenance Manual.

PART 2 PRODUCTS

2.1 GENERAL

A. Valve to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe.

D. Valve ends to suit adjacent piping.

E. Size operator to operate valve for the full range of pressures and velocities.

F. Valve to open by turning counterclockwise.

G. Factory mount operator, actuator, and accessories.

2.2 MATERIALS

A. Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

B. Approved alloys are of the following ASTM designations:

1. B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

2.3 FACTORY FINISHING

A. Epoxy Lining and Coating:

1. Use where specified for individual valves described herein.
2. In accordance with AWWA C550 unless otherwise specified.
3. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
4. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

B. Exposed Valves:

1. In accordance with Section 09900, PAINTING
2. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels “safety yellow.”

2.4 VALVES

A. Gate Valves:

1. Type V100 Gate Valve 3 Inches and Smaller: All-bronze, screwed bonnet, single solid wedge gate, nonrising stem, rated 125-pound SWP, 200-pound WOG.
   a. Manufacturers and Products:
      1) Stockham; B103, threaded end.
      2) Crane; 438, threaded end.
      3) Stockham; B104, soldered end.
      4) Crane; 1324, soldered end.

2. Type V140 Gate Valve, 3/4 Inch to 2 Inches:
   a. UL listed, all-bronze, solid wedge disc, outside screw and yoke, screwed ends rated 175 pound WOG minimum.
   b. Supervisory switch, as specified in Section 15330, FIRE PROTECTION SYSTEM. Valve supervised in OPEN position so closing results in actuation of alarm.
   c. Manufacturers and Products:
      1) Stockham; B133.
      2) Crane; No. 459.
3. Type V142 Gate Valve, 3 Inches to 12 Inches:
   a. UL listed, iron body, bronze mounted, designed for fire protection service, rising stem, outside screw and yoke, ANSI B16.1 flanged ends, rated 175 pound WOG.
   b. Double disc type gate, bronze wedge pins, parallel seat, gate stem in bronze bushing through stuffing box.
   c. Supervisory switch, as specified in Section 15330, FIRE PROTECTION SYSTEM. Valve supervised in OPEN position so closing results in actuation of alarm.
   d. Manufacturers and Products:
      1) Kennedy; Figure 68.
      2) American-Darling; 52U.

B. Globe Valves:

1. Type V200 Globe Valve, 3 Inches and Smaller:
   a. All-bronze, union bonnet, inside screw, rising stem, TFE disc, rated 150-pound SWP, 300-pound WOG.
   b. Manufacturers and Products:
      1) Stockham; B-22T, threaded end.
      2) Crane Co.; 7TF, threaded end.
      3) Stockham; B-24T, soldered end.
2. Type V201 Angle Pattern Valve, 2 Inches and Smaller:
   a. All-bronze, screwed ends, union bonnet, inside screw, rising stem, TFE disc, rated 150-pound SWP, 300-pound WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-222T.
      2) Crane Co.; Cat. No. 17TF.
3. Type V236 Angle Pattern Hose Valve, 1 Inch to 3 Inches:
   a. All-bronze, screwed ends, inside screw, rising stem, TFE disc, outlet of cast brass NHT by NPT, male by male, nipple adapter with hexagonal wrench feature, brass cap with chain, rated 300 WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T.
      2) Crane Co.; Cat. No. 7TF.
      3) Stockham; Figure B-222T.
      4) Crane Co.; Cat. No. 17TF.

5) James Jones Co.; J-300 Series, angle fire hydrant valve with NPT inlet and National Hose thread outlet.
6) ITT Kennedy; Figure 936, angle fire hydrant valve with NPT inlet and National Hose thread outlet.

C. Ball Valves:

1. Type V304 Ball Valve, 2 Inches and Smaller, for General Water and Air Service:
   a. All-bronze, three-piece body type, screwed ends, full bore ports, Teflon seat, blowout-proof stem, hand lever operator, rated 150 psi SWP, 400-pound WOG minimum.
   b. Manufacturers and Products:
      1) Nibco, Inc.; T-595-Y.
      2) Grinnell Supply Sales Co.; Figure 3810.
2. Type V305 Ball Valve, 2 Inches and Smaller, for Natural Gas Service:
   a. Bronze body, screwed ends, Teflon seats and seals, hand-lever operator, UL Listed YRPV, 300 psi rating.
   b. Manufacturers and Products:
      1) Neles-Jamesbury; Figure 356.
      2) Conbraco; Saturn 90-100 Series.

D. Plug Valves:

1. Type V411 Three-Way, Mixing Valve, 1/2 Inch to 2 Inches:
   a. Bronze body Class 250 psi, 0 to 400 degrees F, 316 SS plug, and seat rings.
   b. Valve Operator: Gear type.
   c. Manufacturers and Products:
      1) DeZurik; Style PTW.
      2) Bauman; Model 24000 or equal.
2. Type V420 Non-lubricated Plug Valve, 2 Inches and Smaller:
   a. Ductile iron or carbon steel body, straight-way rectangular ports, Teflon sleeves, screwed ends, wrench operator.
   b. Class: 150.
   c. Rating: 275 pounds WOG.
   d. Manufacturers and Products:
      1) Duriron Co.; Figure No. G432.
      2) Tufline; Figure 066.
3. Type V422 Non-lubricated Plug Valve, 2-1/2 Inches and Larger:
   a. Ductile iron or carbon steel body, straight-way rectangular ports, Teflon sleeves, flanged ends.
   b. Class: 150.
   c. Rating: 275 pounds WOG.
   d. Operator:
      1) 4 Inches and Smaller Valve: Wrench type.
      2) 6 Inches and Larger Valve: Enclosed gear type.

e. Manufacturers and Products:
   1) Duriron Co.; Figure No. G411.
   2) Tufline; Figure 067.

4. Type V462 Gauge Cock, 1/8 Inch to 1/4 Inch:
   a. 1/4-inch bronze body, hexagon end pattern, tee head, male ends, rated 125-pound SWP.
   b. Manufacturer and Product: United Brass Works; Figure 973.

5. Type V466 Buried Service Natural Gas Plug Valve, 2 Inches and Smaller:
   a. UL listed, iron body type, rated 125 psi, screwed ends, drilled key head for permanent pinned operating rod.
   b. Manufacturers and Products:
      1) DeZurik; Figure 425.
      2) Mueller; (gas) curb stop H-11104.

6. Type V471 Combination Balancing and Shutoff Valve, 3 Inches and Smaller for Heating, Chilled, and Cooling Water Service:
   a. Bronze body, brass ball, and carbon filled TFE seat rings.
   b. Screwdriver or hand adjusted ball valve.
   c. Graduated dial indicator.
   d. Line size.
   e. Integral valved readout ports.
   f. Adjustable memory stop.
   g. Drain connection.
   h. Preformed insulation.
   i. Sweat or flanged connections only on systems filled with glycol fluid.
   j. Manufacturers and Product:
      1) Bell & Gossett; Type CB Circuit Setter Plus.
      2) Taco; Series CS Circuit Setter.

7. Type V472 Combination Balancing and Shutoff Valve, 4 Inches and Larger, for Heating, Chilled, and Cooling Water Service:
   a. Non-lubricated plug valve, cast iron or semi-steel body, wrench lever manual operator, EPT resilient plug facing, adjustable memory stop, rated 150-pound WOG minimum, ANSI B16.1 flanged ends.
   b. Manufacturer and Product: DeZurik; Series 100, Figure 118F.

E. Check and Flap Valve:

1. Type V600 Check Valve, 2 Inches and Smaller:
   a. All-bronze, screwed ends and cap, swing type replaceable Buna-N disc, rated 125-pound SWP, 200-pound WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure 320B.
      2) Milwaukee; Figure 510 or 511.

2. Type V604 Check Valve, 2-1/2 Inch to 12 Inches:
   a. Flanged end, cast iron body, bronze mounted swing type, solid bronze hinges, stainless steel hinge shaft, rated 125-pound SWG, 200-pound WOG.
   b. Manufacturers and Products:
      1) Stockham G-931; List 37, Clearway check valve.
      2) Crane Co.; Cat. No. 373.
3. Type V610 Swing Check Valve for Fire Protection Service:
   UL listed, FM approved, iron body, bronze mounted, rated 175 pounds WOG, self-adjusting bronze disc, ends ANSI B16.1 flanged, with a 1-inch NPT tapped and plugged boss.
   a. Manufacturers and Products:
      1) Kennedy; Figure 126.
      2) Mueller; A-2120-6.
4. Type V640 Double Check Valve Backflow Prevention Assembly, 3/4 Inch to 10 Inches:
   a. Two resilient seated check valves, two outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C510, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
   b. Manufacturers and Products:
      1) FEBCO; Model 850.
      2) Cla-Val; Model D-2/D-4.
      3) Watts; Series 007/709.
5. Type V642 Reduced-Pressure Principle Backflow Prevention Assembly, 3/4 Inch to 10 Inches:
   a. Two resilient seated check valves with an independent relief valve between the valves, two outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
   b. Manufacturers and Products:
      1) FEBCO; Model 860.
      2) Cla-Val; Model RP-2/RP-4.
      3) Watts; Series 009/909.

F. Self-Contained Automatic Valves:

1. Type V710 Pressure-Reducing Valve, 2-1/2 Inches and Smaller:
   a. Direct diaphragm operated, spring controlled, bronze body.
   b. Size/Rating: Valve shall be set to maintain a terminal pressure of 5 psi in excess of the static head on the system.
   c. Manufacturers and Products:
      1) Fisher; Type 75A.
      2) Watts; Series 223.

2.5 OPERATORS

A. Manual Operator:

1. General:
   a. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 40 pounds.
   b. Operator self-locking type or equipped with self-locking device.
   c. Position indicator on quarter-turn valves.
   d. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threader steel reach rods with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
   a. Galvanized and painted handwheels.
   b. Lever operators allowed on quarter-turn valves 8 inch and smaller.
   c. Cranks on gear type operators.
   d. Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.
   e. Valve handles to take a padlock, and wheels a chain and padlock.

B. Electric Operator:

1. General:
   a. Comply with AWWA C540.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
   c. Controls integral with the actuator and fully equipped as specified in AWWA 540.
   d. Stem protection for rising stem valves.
2. Actuator Operation-General:
   a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multi-turn valves.
   b. Manually override handwheel.
   c. Valve position indication.
3. Modulating Service:
   a. Size motors for continuous duty.
   b. Feedback potentiometer and integral electronic positioner/comparator circuit to maintain valve position.
   c. HAND-OFF-AUTO (Local-Off-Remote) Selector Switch:
      1) OPEN-STOP-CLOSE pushbutton to control valve in HAND position.
      2) 4 to 20 mA dc input signal to control valve in AUTO position.
      3) Auxiliary contact that closes in REMOTE position.

d. Valves shall close upon loss of signal unless otherwise indicated.
e. OPEN and CLOSED indicating lights.
f. Ac motor with reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Controller capable of 1200 starts per hour.
g. Duty cycle limit timer and adjustable band width to prevent actuator hunting.
h. Valve position output converter that generates a 4 to 20 mA dc signal in proportion to valve position, and is capable of driving into loads up to 500 ohm at 24 volts dc.

4. Actuator Power Supply:
   a. 208-volt, three-phase unless otherwise indicated.
   b. Control power transformer, 120-volt secondary.
   c. Externally operable power disconnect switch.
5. Enclosure:
   a. As defined in NEMA 250, Type 4.
   b. Contain 120-volt space heaters.
6. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable cam-operated, with contacts rated for 5 amps at 120 volts ac.
   b. Each valve actuator to have a minimum of two transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   c. Housed in actuator control enclosure.
7. Manufacturers and Products:
   a. Rotork
   b. EIM Co.
   c. AUMA
   d. Limitorque

2.6 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve operator.

B. Limit Switch:

1. Factory installed limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

PART 3 EXECUTION

3.1 INSTALLATION

A. Flange Ends:

1. Flanged valve boltholes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. Valve Orientation:

1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above finish floor, unless otherwise shown.
3. If no plug valve seat position is shown, locate as follows:
   a. Horizontal Flow: The flow shall produce an “unseating” pressure, and the plug shall open into the top half of valve.
   b. Vertical Flow: Install seat in the highest portion of the valve.

D. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

E. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

3.2 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.

C. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.

D. Set, verify, and record set pressures for all relief and regulating valves.

E. Automatic valve to be tested in conjunction with control system testing.

F. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.3 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at site for minimum person-days listed below, travel time excluded:

1. 1 person-days for installation assistance and inspection.
2. 1 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

B. See Section 01640, MANUFACTURERS' FIELD SERVICES.

END OF SECTION

SECTION 15140
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
2. Building Officials and Code Administrators (BOCA): Basic Building Code.
3. International Conference of Building Officials (ICBO): Uniform Building Code.
4. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. SP 69, Pipe Hangers and Supports - Selection and Application.
   c. SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.

1.2 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state where the Work is to be installed.

1.3 DESIGN REQUIREMENTS

A. General:

1. Seismic Load: Seismic Zone 2A performance category forces with seismic loads in accordance with Section 2312(g), ICBO Uniform Building Code.
2. Design, size, and locate piping support systems throughout facility, whether shown or not.
3. Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89, or as modified by this section.

B. Pipe Support Systems:

1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.
2. Maximum Support Spacing and Minimum Rod Size:
   a. Mild Steel or Ductile Iron Piping:

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
1" & smaller	6 feet	1/4"
1-1/2" through 2-1/2"	8 feet	1/4"
3" & 4"	10 feet	3/8"
6"	12 feet	3/8"
8"	12 feet	1/2"

   b. Copper Piping:
      1) Maximum Support Spacing: 2 feet less per size than listed for steel pipe, with 1 inch and smaller pipe supported every 5 feet.
      2) Minimum Hanger Rod Sizing: Same as listed for steel pipe.
   c. Plastic Piping:
      1) Maximum support spacing: As recommended by manufacturer for flow temperature in pipe.
      2) Minimum Hanger Rod Sizing: Same as listed for steel pipe.

C. Framing Support System:

1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
2. Column Members: Size in accordance with manufacturer's recommended method.
3. Support Loads: Calculate using weight of pipes filled with water.
4. Maximum Spans:
   a. Steel and Ductile Iron Pipe, 3-Inch Diameter and Larger: 10-foot centers, unless otherwise shown.
   b. Other Pipelines and Special Situations: May require supplementary hangers and supports.

D. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

E. Vertical Sway Bracing: 10-foot maximum centers, or as shown.

F. Existing Support Systems: Use existing supports systems to support new piping only if CONTRACTOR can show that they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.1 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.

B. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

C. Materials: In accordance with Tables 1 and 2, attached as supplements to this section.

2.2 HANGERS

A. Clevis Type: MSS SP 58 and SP 69, Type 1 or 6.

1. Grinnell; Figure 104 or 260.
2. B-Line; Figure B3198 or B3100.

B. Hinged Split-Ring Pipe Clamp: MSS SP 58 and SP 69, Type 6 or 12.

1. Grinnell; Figure 104.
2. B-Line; Figure B3198H.

C. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

D. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58 and SP 69, Type 21, 28, 29, or 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58 and SP 69, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2.3 SADDLE SUPPORTS

A. Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.

1. Nonadjustable Saddle: MSS SP 58 and SP 69, Type 37 with U-bolt.
   a. Grinnell; Figure 259.
   b. B-Line; Figure B3090.

2. Adjustable Saddle: MSS SP 58 and SP 69, Type 38 without clamp.
   a. Grinnell; Figure 264.
   b. B-Line; Figure B3093.

2.4 WALL BRACKETS

A. Welded Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).

1. Grinnell; Figure 199.
2. B-Line; Figure B3067.

B. One-Hole Clamp: Grinnell; Figure 126.

C. Channel Type:

1. Unistrut.
2. Grinnell; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.5 PIPE CLAMPS

A. Riser Clamp: MSS SP 58 and SP 69, Type 8.

1. Grinnell; Figure 261.
2. B-Line; Figure B3373.

2.6 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for all loads with safety factor of 5.

C. Manufacturers:

1. B-Line; Strut System.
2. Unistrut.
3. Grinnell; Power-Strut.
4. Aickinstrut (FRP System).

2.7 ACCESSORIES

A. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58 and SP 69, Type 40.
2. Manufacturers and Products:

a. Grinnell; Figure 167.
b. B-Line; Figure B3151.

B. Vibration Isolation Pads:

1. Type: Neoprene Waffle.
2. Manufacturers and Products:
   a. Mason Industries; Type W.
   b. Korfund; Korpad 40.

C. Flush Type Insert Channels: As specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 69 and MSS SP 89, unless shown otherwise.
2. Support piping connections to equipment by pipe support and not by equipment.
3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
4. Support no pipe from pipe above it.
5. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
6. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
7. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
8. Install lateral supports for seismic loads at all changes in direction.
9. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
10. Repair mounting surfaces to original condition after attachments are made.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Adjustable swivel-ring, split-ring, or clevis hangers.
   b. Grouped Pipes: Trapeze hanger systems.
   c. Furnish galvanized steel protection shield and oversized hangers for insulated pipe.
   d. Furnish precut sections of rigid insulation with vapor barrier at hangers for insulated pipe.

2. Horizontal Piping Supported From Walls:
   a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.
   b. Stacked Piping:
      1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.
      2) Piping clamps that resist axial movement of pipe through support not acceptable.
   c. Wall mounted piping clips not acceptable for insulated piping.
3. Horizontal Piping Supported From Floors:
   a. Stanchion Type:
      1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
      2) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above floor and for exterior installations.
      3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
   b. Floor Mounted Channel Supports:
      1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
      2) Attach channel framing to floors with anchor bolts.
      3) Attach pipe to channel with clips or pipe clamps.
   c. Concrete Cradles: Use for piping larger than 3 inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
5. Standard Attachments:
   a. To Concrete Ceilings: Concrete inserts.
   b. To Steel Beams: I-beam clamp or welded attachments.
   c. To Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
   d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
6. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

C. Accessories:

1. Insulation Shield: Install on insulated nonsteel piping. Oversize rollers and supports.

2. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
3. Dielectric Barrier:
   a. Install between carbon steel members and copper or stainless steel pipe.
   b. Install between stainless steel supports and nonstainless steel ferrous metal piping.
4. Electrical Isolation: Install 1/4-inch by 3-inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

3.2 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09900, PAINTING.

END OF SECTION

SECTION 15150
DRAIN, WASTE, VENT, AND ROOF DRAINAGE PIPING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): B16.12, Cast Iron Threaded Drainage Fittings.
2. American Society for Testing and Materials (ASTM):
   a. A47, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
   d. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   e. A536, Standard Specification for Ductile Iron Castings.
   f. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
3. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
   b. 310, Specification for Coupling for Use in Connection with Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.

1.2 SUBMITTALS

A. Shop Drawings: Sanitary and Waste Drains and Vents

PART 2 PRODUCTS

2.1 SANITARY AND WASTE DRAINS AND VENTS

A. Galvanized Piping Systems:

1. Pipe: Carbon steel, galvanized, furnace butt welded, ASTM A53, Grade F, Schedule 40.
2. Fittings:
   a. Cast iron, galvanized, screwed drainage fittings, ASTM A126, Class B, dimensions conforming to ANSI B16.12.
   b. Malleable iron, ductile iron, or galvanized steel grooved end galvanized drainage fittings, materials conforming to ASTM A47,

ASTM A536, and ASTM A53, Grade B, respectively, permitted in aboveground roof drainage systems only.

3. Joints:
   a. Screwed threads conforming to ASTM A47, made with teflon tape or joint compound that is insoluble in water.
   b. Grooved end joints are permitted in aboveground roof drainage systems.

B. Hubless Cast Iron Piping Systems:

1. Pipe: Cast iron soil pipe, service weight, conforming to CISPI 301.
2. Fittings: Cast iron soil pipe, service weight, conforming to CISPI 301.
3. Joints: Hubless type, with neoprene sealing sleeve, shield and clamp assembly, conforming to CISPI 310.

C. Hub-and-Spigot Cast Iron Piping Systems:

1. Pipe: Cast iron soil pipe, service weight, conforming to ASTM A74.
2. Fittings: Cast iron soil pipe, service weight, conforming to ASTM A74.
3. Joints: Hub-and-spigot, with rubber gasketed, push-on gaskets conforming to ASTM C564.

PART 3 EXECUTION

3.1 SANITARY AND WASTE DRAIN AND VENT PIPING

A. Install sanitary and waste drain and vent piping above floor slab, true and plumb.

B. Install exposed risers as close to walls as possible.

C. Where vent stacks pass through roof slab, fit with flashing sleeve for securing roofing. Make flashing and roof connection watertight. Extend vents at least 1-foot above roof.

D. Changes of direction in waste piping shall be made with combination Y and 1/8 bend fittings.

E. Install cleanout fittings and plugs where shown and where required by plumbing code. Cleanout fittings shall be T or Y branches or trap hubs of same material and size as the pipe in which they are installed.

F. Sizes and System Types:

1. Within Buildings, Above Slab:
   a. 1-1/2-Inch and Smaller: Galvanized steel.

b. 2 Inches Thru 6 Inches: Hubless cast iron.
c. 8 Inches and Larger: Hub-and-spigot cast iron.
2. Under Slab, Buried, 2 inches and Larger: Hub-and-spigot cast iron.

3.2 ROOF DRAINAGE PIPING

A. Changes of direction in horizontal roof drainage piping shall be made with 45-degree fittings. Changes of direction in underground lines shall be made with combination Y and 1/8 bend fittings.

B. Install cleanout fittings and plugs where shown and where required by plumbing code. Cleanout fittings shall be the same material and size as pipe in which they are installed.

C. Sizes and System Types:

1. Within Buildings, Above Slab:
a. 6 Inches and Smaller: Galvanized steel, screwed or grooved end; hubless cast iron.
b. 8 inches and Larger: Hub-and-spigot cast iron.
2. Under Slab, Buried: Hub-and-spigot cast iron.

3.3 BUILDING DRAINAGE VENTS

A. Sizes and System Types:

1. 3 Inches and Smaller: Galvanized steel.
2. 4 Inches and Larger: Hub-and-spigot cast iron.

3.4 SUPPORTS AND HANGERS

A. Support cast iron soil pipe at every hub and change of direction in accordance with Section 15140, PIPING SUPPORT SYSTEMS.

3.5 FIELD TESTS

A. Hydrostatically test piping at pressures listed in the governing plumbing code.

END OF SECTION

SECTION 15250
PIPING INSULATION

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society for Testing and Materials (ASTM):
   a. C518, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   b. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by means of the Guarded-Hot-Plate Apparatus.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   d. E96, Test Methods for Water Vapor Transmission of Materials.
2. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings.

1.2 SUBMITTALS

A. Shop Drawings: Manufacturer's descriptive literature.

PART 2 PRODUCTS

2.1 PIPE INSULATION

A. Type 1:

1. Material: Flexible elastomeric pipe insulation, closed cell structure.
2. Temperature Rating: Minus 40 degrees F to 180 degrees F.
3. Nominal Density: 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1 and minimum of 0.27 BTU-in/hr-ft^2 degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Minimum water vapor transmission of 0.10 perm-inch per ASTM E96.
6. Seal joints with manufacturer’s adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Manufacturers and Products:
   a. Rubatex; R-180-FS.
   b. Armstrong; Armaflex AP.

B. Type 2:

1. Material: UL rated, preformed, sectional rigid fiberglass with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and minimum of 0.27 BTU-in/hr-ft^2 degrees F.
4. Minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Manufacturers and Products:
   a. Owens-Corning Fiberglass; ASJ/SSL-11.
   b. Manville; Micro-Lock 650 with AP-T Jacket.

2.2 FITTING INSULATION

A. Type 1: Same as pipe.

B. Type 2:

1. Wired in-place premolded insulation or mitered segments, or soft fiberglass insulation inserts covered with premolded 20-mil minimum thickness PVC fitting covers.
2. Manufacturers:
   a. Manville Zeston.
   b. Speedline.
   c. Proto.
   d. CEEL-CO.

2.3 INSULATION AT PIPE HANGERS AND SUPPORTS (REFER TO SECTION 15140, PIPING SUPPORT SYSTEM)

A. Type 1:

1. Copper and Nonmetallic Pipe 2 Inches and Smaller and Steel Pipe 1-1/2 Inches and Smaller: Use insulation shields.
2. Larger Sizes: Use insulation saddles or Type 3 rigid insulation insert 10 inches long.

B. Type 2: UL rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 10 inches in length, with factory applied, vinyl-coated and embossed vapor barrier jacket with self-sealing lap.

PART 3 EXECUTION

3.1 APPLICATION

Minimum Pipe Insulation (inches) (Note 1) (ASHRAE 90.1)								
	Insulation Conductivity		Nominal Pipe Diameter (Inches)					
Fluid Design Operating Temperature Range (Degree F)	Conductivity Range BTU x in./(h x sq ft x Degree F)	Mean Rating Temperature (Degree F)	Runouts up to 2 (Note 2)	1 and less	1-1/4 to 2	2-1/2 to 4	5 & 6	8 & Up
Heating Systems (Steam, Steam Condensate, and Hot Water)								
Above 350	0.32 - 0.34	250	1.5	2.5	2.5	3.0	3.5	3.5
251 - 350	0.29 - 0.31	200	1.5	2.0	2.0	2.5	3.5	3.5
201 - 250	0.27 - 0.30	150	1.0	1.5	1.5	2.0	2.0	3.5
141 - 200	0.25 - 0.29	125	0.5	1.5	1.5	1.5	1.5	1.5
105 - 140	0.24 - 0.28	100	0.5	1.0	1.0	1.0	1.5	1.5
Domestic and Service Hot Water Systems (Note 3)								
105 and Greater	0.24 - 0.28	100	0.5	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled water, brine, and refrigerant) (Note 4)								
40 - 55	0.23 - 0.27	75	0.5	0.5	0.75	1.0	1.0	1.0
Below 40	0.23 - 0.27	75	1.0	1.0	1.5	1.5	1.5	1.5

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to table below and to Piping Schedule in Section 15060, PIPING - GENERAL.

Service and Insulation Thickness			
Service Type	**Thickness Determined By**	**Fluid Temperature (degrees F) ***	**Insulation**
HG - Heating Systems (hot water)	ASHRAE 90.1	201 to 250	Type 2
DW - Domestic and Service Hot Water Systems.	ASHRAE 90.1	105 and greater	Type 2
CS - Cooling Systems (Condensate control and refrigerant)	ASHRAE 90.1	40 to 55	Type 2
* Use these fluid temperatures unless otherwise noted in the Piping Schedule.			

B. PVC Fitting Covers: Install on Type 2 insulated interior piping.

3.2 INSTALLATION

A. General:

1. Install in accordance with manufacturer's instructions and as specified herein.
2. Install insulation after piping system has been pressure tested and leaks corrected.
3. Apply insulation over clean finish painted and dry surfaces.
4. Do not allow insulation to cover nameplates or code inspection stamps.
5. Run insulation continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
6. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
7. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
2. Insulate valves and fittings with sleeved or cut pieces of same material.
3. Seal and tape joints.

E. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

F. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

3.3 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

END OF SECTION

SECTION 15445
PLUMBING FIXTURES AND EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90A, Energy Conservation in New Building Design.
2. American Society of Mechanical Engineers (ASME): Section IV PT HLW.
3. Underwriters Laboratories (UL): Electrical Appliance and Utilization Equipment Directory.

1.2 SUBMITTALS

A. Shop Drawings:

1. Drawings showing changes in locations of fixtures or equipment that are advisable in the opinion of CONTRACTOR.
2. Manufacturers' product data for fixtures and equipment.

B. Contract Closeout Submittals: Special guarantee.

PART 2 PRODUCTS

2.1 GENERAL

A. Furnish plumbing fixtures with chrome-plated flexible water supplies, angle stops, and canopy flanges at wall.

B. Furnish lavatories, sinks, and drinking fountains with chrome-plated cast brass P-traps, trap arms, and canopy flange at wall.

2.2 FIXTURES

A. LAV-1 Lavatory:

1. Counter top self-rimming, oval, white.
2. Maximum Water Consumption: 0.5 gpm.

3. Manufacturers and Products:
   a. American Standard; Horizon 3303.013 with 2385.478 faucet, grid strainer and tailpiece.
   b. Kohler; Farmington K-2904 with K-15199 faucet, grid strainer and tailpiece.

B. SH-1 Shower Trim:

1. Pressure compensating valve with integral check stops, and 2 gpm flow control.
2. Install shower head 78 inches above finished floor.
3. Manufacturers and Products:
   a. Symmons; Safetymix S-1-100X, 4-131F adjustable shower head.
   b. Speakman; Sentinel Mark II Regency SM-1400-AF-2-1S.

C. WC-1 Water Closet (Flush Valve-Wall-Hung Type):

1. Elongated bowl.
2. Maximum Water Consumption: 1.6 gallons per flush.
3. Manufacturers and Products:
   a. American Standard; Afwall 2257.103.
   b. Kohler; Kingston K-4330.
4. Flush Valve Manufacturers and Products:
   a. Sloan; Royal 111.
   b. Delaney; 402-1.
5. Commercial Type Closet Support Manufacturers:
   a. J. R. Smith.
   b. Josam.

D. Water Closet Seat:

1. White open-front.
2. Manufacturers and Products:
   a. Olsonite; No. 95.
   b. Kohler; K-4666-SC.

E. UR-1 Urinal (Wall-Hung Type):

1. Maximum Water Consumption: 1 gallon per flush.
2. Manufacturers and Products:
   a. American Standard; Washbrook 6501.010.
   b. Kohler; Bardon K-4960-T.
3. Flush Valve Manufacturers and Products:
   a. Sloan; Royal 186-1.
   b. Delaney; 451-1.

4. Commercial Type Urinal Support Manufacturers:
   a. J. R. Smith.
   b. Josam.

2.3 DRAINS

A. FD-2 Floor Drain:

1. Galvanized cast iron body and grate, flashing collar, removable sediment bucket, cast iron P-trap, trap primer connection.
2. Manufacturers and Products:
   a. J. R. Smith; Figure 2220.
   b. Zurn; Z-550-Y.

B. FD-1 Floor Drain:

1. Cast iron body, flashing collar, 6-inch diameter chrome-plated adjustable strainer, removable sediment bucket, cast iron P-trap, trap primer connection.
2. Manufacturers and Products:
   a. J. R. Smith; Figure 2010-A.
   b. Zurn; Z-415.

2.4 CLEANOUTS

A. FCO-Floor Cleanout:

1. Cast iron body and frame, and square, adjustable, scoriated, nickel-bronze top.
2. Manufacturers and Products:
   a. J. R. Smith; Figure 4023.
   b. Zurn; Z-1400-2.

2.5 HOSE VALVES AND HYDRANTS

A. HV-1 Wall Hydrant:

1. Nonfreeze box type with chrome-plated face, integral vacuum breaker, bronze casing, T-handle key, and ¾-inch inlet and hose connection.
2. Manufacturers and Products:
   a. J.R. Smith; Figure 5509
   b. Josam; 71000 Series.

2.6 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arrestors

1. Manufacturers and Products:
   a. J.R. Smith; Series 5000
   b. Wade; No. W-10

PART 3 EXECUTION

3.1 INSTALLATION

A. Field Obstructions:

1. Install fixtures and equipment in accordance with manufacturer's piping diagrams and instructions.
2. Drawings do not attempt to show exact details of fixtures, nor integral piping accessories for fixtures and equipment to be installed.
   a. Provide offsets around local obstructions.
   b. Change location of fixtures and equipment only when approved by COTR/CM.
   c. Verify measurements and dimensions at the site.
3. Preparation and alteration of structural components required for fixtures and equipment to be installed shall be as approved by COTR/CM.

B. Plumbing Fixtures and Drains:

1. Trap and vent each plumbing fixture as required by code.
2. Install fixtures and drains true and plumb with separate stops for each fixture supply.
3. Do not use galvanized nipples between copper water supply and angle stops.
4. Provide chrome-plated escutcheons at pipe penetrations of floors, walls, and ceilings.

C. Mounting Heights Above Finished Floor:

1. SH-1 Shower Trim: 78 inches to shower head.

D. Water Hammer Arrestors

1. Install in piping systems where shown, and adjacent to pieces of equipment wherein quick closing valves are installed.
2. Size and install in accordance with Plumbing and Drainage Institute Standard PDI–WH201.

3.2 FIELD TESTS

A. Prior to operational startup, inspect and test installed fixtures and equipment for proper connections and operation.

3.3 ADJUSTING/CLEANING

A. At end of construction, clean plumbing fixtures, faucet aerators, and drains. Replace fixtures and/or accessories damaged during construction.

B. Adjust fixtures and equipment and leave in a working condition.

END OF SECTION

SECTION 15500
HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Moving and Conditioning Association (AMCA):
   a. Bulletin 300, Reverberant Room Method for Sound Testing of Fans, Setup No. 1.
   b. Standard 99, Standards Handbook.
   c. Standard 210, Laboratory Methods of Testing Fans for Rating.
   d. Standard 2401, Impeller Diameters and Outlet Areas for Centrifugal Fans and Metric Equivalents.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., (ASHRAE): 90A, Energy Conservation in New Building Design.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
4. National Electrical Manufacturers Association (NEMA): MG 1-12.53a, Motors and Generators.
5. National Fire Protection Association (NFPA):
   a. 30, Flammable and Combustible Liquids Code.
   b. 54, National Fuel Gas Code.
   c. 88B, Standard for Repair Garages.
   d. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   e. 90B, Standard for the Installation of Warm Air Heating and Air Conditioning.
   f. 91, Standard for Exhaust Systems for Air Conveying of Materials.
   g. 820, Recommended Practice for Fire Protection in Wastewater Treatment and Collection Facilities.
6. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):
   a. Guidelines for Seismic Restraints of Mechanical Systems.
   b. HVAC Duct Construction Standards-Metal and Flexible.
7. HVAC Testing, Adjusting, and Balancing Manual.
8. International Conference of Building Officials, Uniform Fire Code (UFC):
   a. Article 79, Flammable and Combustible Liquids.
   b. Article 80, Hazardous Materials.

1.2 SUBMITTALS

A. Shop Drawings:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
2. Complete performance data that indicates full compliance with the Specifications.
3. Recommended procedures for protection and handling of equipment and materials prior to installation.

B. Quality Control Submittals:

1. Manufacturer's certification of factory testing to establish conformance with specified requirements for the air supply units.
2. Recommended procedures for protecting and handling of equipment and materials prior to installation.
3. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.
4. Operation and maintenance manuals.
5. List of recommended spare parts for equipment and materials specified.

PART 2 PRODUCTS

2.1 GENERAL

A. Heating Equipment: Minimum operating efficiencies as specified in Chapter 6 of ASHRAE Standard 90A.

B. Fans shall have sound power level data (ref. 10 to -12 watts) at design operating point; ratings shall be based on AMCA Bulletin 300, Setup No. 1.

2.2 AIR-COOLED CONDENSING UNIT

A. Condensing Section:

1. Condenser coil(s).
2. Fan(s).
3. Motors.
4. Two reciprocating or scroll compressors.
5. Refrigerant specialties.
6. Controls.
7. Contained in a weatherproof casing.
8. Installed on weather-resistant 1–inch thick sandwich isolation pad of neoprene waffle bottom and flat top pads with cork center core.
9. Bearing the UL label.

B. Casing:

1. 18–gauge zinc-coated steel phosphatized and finished in manufacturer's standard enamel paint.
2. Supported on steel full-length mounting rails.
3. Removable access panels to all internal components.
4. Protective guards on each fan discharge and each coil inlet.

C. Cooling Components:

1. Spring mounted hermetic compressor.
2. Crankcase heater.
3. Liquid line solenoid.
4. Suction line accumulator.
5. Condenser coil with seamless copper tubes bonded to aluminum fins.
6. Rubber mounted upflow propeller condenser fans with direct-drive motor with integral thermal overload protection.
7. Connections for refrigerant piping and specialties.

D. Control Section:

1. Starters for compressor and all fans.
2. Overload protection in each leg.
3. HIGH and LOW pressure refrigerant controls.
4. Refrigerant-side condenser fan controls.
5. Compressor winding and overheat protection.
6. Antishort cycle device.
7. Terminal strip for connection of remote controls.
8. A hot gas bypass valve and compressor unloaders shall provide capacity modulation of the first-stage cooling coil.
9. Lead compressor shall serve first-stage of DX coil in AHU-1.
10. The lag compressor shall energize on further demand for cooling.

E. Units with multiple compressors shall have completely independent refrigeration circuits and controls.

F. Manufacturers and Products: Design is based on the listed manufacturer and products; products of other manufacturers shall be considered in accordance with Section 01600.

1. Trane; Model RAUC.

2.3 AIR HANDLING UNITS

A. Furnish fused disconnects on fan units.

B. Acoustical Levels:

1. Air handlers listed below are critical for proper acoustical design of the adjacent spaces.
2. Make equipment selections that produce sound power levels in each of the octave bands no greater than shown.
3. Perform noise tests in accordance with AMCA 300.
4. Maximum dB Sound Power Levels by Octave Band (Reference 10 to the –12 Watts):

Sound Power Level (dB)								
	Octave Band Center Frequency (Hz)							
Air Handling Unit No. 1	63	125	250	500	1000	2000	4000	8000
Supply Fan	96	93	85	84	85	84	77	71
Return Fan	93	86	75	79	77	77	73	70
Casing	95	86	77	73	72	66	59	57

C. General:

1. Complete draw-through assembly, including:
   a. Fan sections (supply and return).
   b. Coils.
   c. Filters.
   d. Mixing box.
   e. Accessories.
   f. Economizer section.
2. Enclosed in a double wall insulated steel casing.
3. Finish: Galvanized.
4. Access Doors: Hinged, gasketed, and located to allow access to internal components.

D. Casing for Sections:

1. 16–gauge double wall galvanized steel skid mounted on structural steel frame.
2. Interior surfaces insulated with 1–inch thick, 1.5–pound density, neoprene-coated fiberglass insulation.

E. Fan Sections (Supply and Return):

1. Internally spring isolated.
2. Double-width, double-inlet, centrifugal fan.
3. Forward-curved blades.
4. Blades welded or securely fastened to rim and hub plate.
5. Involute form scroll.

6. Solid or tubular steel shaft.
7. Grease-lubricated, self-aligning pillow-block bearings with grease fittings accessibly located.
8. Flexible connection between fan discharge and casing.
9. Equip with variable frequency motor for variable air volume control.

F. Water Heating Coil:

1. Completely drainable and cleanable.
2. Nonferrous extended surface type with fins mechanically bonded to copper tubes on same side of coil. Coordinate side of coil connections with floor plans. Coil connections shall be accessible.
3. 0.010–inch minimum fin thickness.
4. 0.025–inch minimum tube wall thickness.
5. Tubes rolled into headers with copper bushings.
6. Tubes without turbulators.
7. Arranged for counterflow between air and water.
8. Supply and return connections on same side.
9. Pressure-equalizing baffles as required.
10. ARI 410 performance rated.

G. Direct-Expansion Cooling Coil:

1. Suitable for use with R–22 refrigerant.
2. Furnish Venturi type refrigerant distributors with male sweat connections on same side of coil. Coordinate side of coil connections with floor plans. Coil connections shall be accessible.
3. Equal resistance distributor tubes and independent circuiting.
4. Tubes and Header:
   a. Seamless copper tubes.
   b. Mechanically expand tubes into nonferrous plate fins.
5. Coil to be cleaned, dehydrated, evacuated, charged with dry nitrogen, and sealed before shipment.
6. Holding charge must still be in coil when seal is broken, or coil must be re-evacuated and dehydrated in the field prior to connection.
7. Furnish drain pan under cooling coil with drainpipe connections on each end.
8. Twin Cooling Coils:
   a. Arrange for intertwined circuit type.
   b. Each section to contain a suction header, distributor, and distributor circuiting as required for capacity conditions.
   c. Provide for capacity control below last compressor step with a hot gas solenoid valve and a hot gas bypass reinjection valve.
   d. Valves: As furnished by manufacturer.
   e. Valve and Bypass Size: As recommended by manufacturer.
9. ARI 410 performance rated.

H. Filters:

1. 2–inch thick strainer type with pleated nonwoven fabric media.
2. Rated at 30 percent efficiency and 90 percent average arrestance in accordance with ASHRAE 52.
3. Arranged in a suitable leak-tight frame and enclosure.
4. Furnish hinged access doors in each end of the filter section with a withdrawal tab for removing filter sections.
5. Maximum Filter Face Velocity: 350 fpm.
6. Filter Box: Suitable for direct attachment to other unit accessories.
7. Manufacturers and Products:
   a. Farr; Type 30/30.
   b. Tri-Dim; Tridek.

I. Mixing Section:

1. Include mixing dampers on return and outside air inlets of the type shown.
2. Set parallel-blade dampers to merge airstreams inside the box.
3. Position opposed-blade dampers across the short dimension of each air opening, with linkage arranged so corresponding outside and return air dampers move together.
4. Where opposed-blade dampers are required in filter mixing boxes, furnish either the combination style box, or a two-piece assembly with a vee filter box and high efficiency mixing box bolted together.
5. Install damper linkage at the factory to provide minimum and maximum damper segments proportional to quantities of minimum and maximum outside air requirements

J. Inspection Plenum Module:

1. Install on upstream side of heating coil module.

K. Return/Exhaust Section:

1. Double-width, double-inlet, centrifugal wheel.
2. Forward-curved blades.
3. Exhaust plenum with exhaust and return motorized opposed-blade dampers.
4. Internal support frame for fan and motor assembly.
5. Frame mounted pillow-block bearings.
6. Fan flexible connections.
7. Internally spring isolated.

L. Manufacturers and Products: Design is based on the listed manufacturer and products; products of other manufacturers shall be considered in accordance with Section 01600.

1. Trane; Modular Climate Changer.

2.4 IN-LINE CENTRIFUGAL FANS

A. Fans:

1. Constructed of low carbon steel, belt-driven and painted with an approved rust-resistant coating.
2. Inlets: Fully streamlined.
3. Housing:
   a. Suitably braced to prevent vibration or pulsation.
   b. Arc-welded steel throughout.
4. Fan Wheel:
   a. Die-formed airfoil or BI blades designed for maximum efficiency and quiet operation.
   b. Continuously weld blades to back plate and to wheel cone.
5. Equip with an adjustable motor base integral with the fan housing.
6. Motor base completely welded, consisting of frame and reinforcing side sheets to assure maximum strength and rigidity.

B. Bearings:

1. Ball or roller anti-friction type.
2. Equipped with extended lubrication lines to grease fittings outside of the fan housing.
3. Shafts shall operate at no more than 70 percent of first critical speed to assure smooth operation.

C. Fused disconnect.

D. Manufacturers and Products:

1. Greenheck; Model BSQ.
2. ACME; Centri Master Model XB Series.

2.5 REFRIGERANT PIPING AND INSULATION

A. Tubing:

1. Hard-drawn copper tubing in accordance with ASTM B75 or ACR copper tubing in accordance with ASTM B68 and B280.
2. Wrought copper fittings.

3. Piping to be evacuated, charged with dry nitrogen and capped at the factory.

B. Insulation:

1. Flexible elastomer.
2. Rated for 25/50 flame spread/smoke developed.
3. Expanded, closed-cell.
4. 1/2-inch thick.
5. Thermal conductivity equals 0.27 or less.
6. Armstrong, Armaflex AP/

2.6 EQUIPMENT ACCESSORIES

A. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number indicated in this Specification and as shown.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests for Air Supply Units:

1. Water Heating Coil: No leaks when tested underwater with 200 psi air.
2. Direct Expansion Cooling Coil: No leaks when tested underwater with 300 psi air.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment and systems in accordance with manufacturers' instructions.

B. Condensing Units: Provide refrigeration specialties, combination temperature/pressure gauges, piping, and refrigerant as required by the manufacturer's installation instructions.

C. Packaged Ground Mounted Air Conditioning Units:

1. Mount level and according to manufacturer's instructions.
2. Provide access for maintenance.

D. Fans and Air Handlers:

1. Pipe drain pan connection through a running trap to floor drain.
2. Isolate sheet metal duct connections from noninternally spring-isolated fan units or other rotating equipment with flexible connections at unit.
3. Locate units approximately where shown to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.
4. Units with Multiple Heating or Cooling Coils: Pipe such that each coil has a manual balancing cock and gauge cock as required for water balancing.
5. Inspect internal casing insulation, seal exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.
6. Seismic Restraints:
   a. Use lateral and vertical motion limiters described in the latest edition of SMACNA "Guidelines For Seismic Restraints of Mechanical Systems."
   b. Restraint Snubbers: Rubber-faced, securely anchored to the floor or structure, and installed with sufficient clearance so that unit isolators are not restricted for proper free isolation but do limit movement.

E. Refrigerant Piping:

1. Size, arrange, and install in accordance with the condensing unit manufacturer's instructions.
2. Provide silvaloy joints.
3. Continuously purge piping with pre-pure dry nitrogen during soldering.
4. Evacuate piping system to 29.9 inches mercury. System shall hold vacuum for 24 hours without significant loss.

F. Refrigerant Pipe Insulation:

1. Install on suction and hot gas bypass lines.
2. Coat UV-exposed insulation to protect from deterioration in accordance with the manufacturer's recommendation.

3.2 AIR HANDLING

A. Shafts and Drive Belts:

1. Provide multiple drive belts where motor horsepower is 2 hp or larger.
2. Belt Guards: Meet federal and State of Illinois OSHA requirements for safety protection, and be easily removable by one person.
3. Tachometer Access Holes: Large enough to accept standard tachometer drive shaft.
4. Centerpunch fan shaft to accommodate tachometer readings.

B. Vibration:

1. Statically and dynamically balance fan equipment.

C. Fan Equipment: Rated and tested in accordance with AMCA Standards 210 and 2401 for Class I service, unless otherwise specified.

D. Ball Bearings:

1. For Forward-Curved Fans: Size for minimum life L-10 of over 80,000 hours.
2. For Airfoil and Backward Inclined Fans: Size for minimum life L-10 of over 40,000 hours, with an average life L-50 of over 200,000 hours.

E. Drives for Belt-Driven Fans:

1. Sheaves shall be capable of providing 150 percent of motor horsepower.
2. Motors shall be mounted on adjustable motor brackets.
3. Motors 10 hp and under shall be provided with adjustable speed sheaves that allow for 20 percent speed variation.
4. Belt-driven fans shall be provided with cast iron or flanged steel sheaves.

F. Air Filters, Fans, Air Handlers, and Air Conditioners: Meet requirements of NFPA No. 90A or No. 90B.

END OF SECTION

SECTION 15515
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. American Society of Mechanical Engineers (ASME).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
4. National Electrical Manufacturers Association (NEMA):
   a. MG 1-12.53a, Motors and Generators.
   b. NEMA 250.
5. Occupational Safety and Health Act (OSHA).

1.2 SUBMITTALS

A. Shop Drawings:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature including make, model, dimensions, weight of equipment, and electrical schematics, for products specified.

B. Quality Control Submittals:

1. Recommended procedures for protection and handling of equipment and materials prior to installation.

C. Contract Closeout Submittals: Operation and maintenance manuals.

PART 2 PRODUCTS

2.1 SUPPLEMENTS

A. See supplements to this section for additional product information.

2.2 HYDRONIC SPECIALTIES

A. Expansion Tank:

1. Steel, diaphragm type with heavy-duty butyl rubber bladder.
2. ASME rated for 180 degrees F working temperature and 125 psi working pressure.

3. Acceptance Volume: 11 gallons hot water.
4. Manufacturers and Product:
   a. Taco; CA.
   b. Amtrol; Extrol AX Series.
   c. Bell & Gossett.

B. Pot Feeder: Bypass feeder for injecting chemical treatment into closed loop systems.

1. Feeder Working Pressure: 150 psi.
2. Manufacturers and Products:
   a. Aqua-Serv; Type HV, 3-gallon capacity.
   b. Neptune; Model VS-BF, 2-gallon capacity.

C. Pressure and Temperature Test Plug:

1. Brass body.
2. 1/4-inch NPT.
3. Removable threaded brass protective cap.
4. Dual neoprene core rated for 200 degrees F.
5. Manufacturer and Product: Sisco; Model BNE-025.

D. Air Separator:

1. Full-line size without strainer.
2. Tangential construction.
3. Steel tank with stainless steel collector tube.
4. ASME constructed for 125 psig operating pressure.
5. Blowdown connection.
6. Capacity: 30 gpm hot water @ 1.0 ft of water
7. Manufacturers and Products:
   a. Taco, 400 Series; AC3 (hot water).
   b. Bell & Gossett; Rolairtrol.
   c. Spirotherm; Spirovent.

E. Automatic Air Vent: Brass body with nonferrous internals.

1. Manufacturers and Products: For 35 psig maximum working pressure and 230 degrees F maximum operating temperature.
   a. Hoffman; No. 77.
   b. Bell & Gossett; No. 67.

F. Manual Air Vents: Brass body with nonferrous internals.

1. Maximum Operating Pressure: 150 psig.
2. Maximum Operating Temperature: 225 degrees F.
3. Manufacturer and Product: Bell & Gossett; No. 4V.

G. Drain and Charge Valve: Brass body with nonferrous internals.

1. Maximum Operating Pressure: 125 psig.
2. Maximum Operating Temperature: 240 degrees F.
3. Manufacturers and Products:
   a. Bell & Gossett; Drain-O-Tank DT-2.
   b. Taco; Air-Scoop.

H. Pressure Relief Valve:

1. ASME rated.
2. Bronze body.
3. EPDM diaphragm.
4. Maximum Operating Temperature: 250 degrees F.
5. Maximum Operating Pressure: 125 psig.
6. Relief Pressure: 30 psig.
7. Manufacturers and Products:
   a. Bell & Gossett; Type 790 or 1170.
   b. Taco; No. 321.

I. Pressure Reducing Valve:

1. 3/4-inch cast iron body.
2. Brass mounted.
3. Integral strainer and antisiphon check valve.
4. Factory Pressure Setting: 12 psig with adjustable range of 8 to 25 psig.
5. Manufacturers and Products:
   a. Bell & Gossett; No. 12.
   b. Taco; No. 329.

2.3 HEATING WATER PUMPS (P-1 & 2)

A. Centrifugal Type Pipeline Mounted Pump:

1. In-line pumps shall be the single stage, close-coupled centrifugal type. Pumps shall be constructed as follows:
2. Impeller shall be the enclosed type and shall be hydraulically and dynamically balanced.
3. Bearings shall be grease lubricated and bearing housing shall be designed so as to flush lubricant through and provide continuous cleaning of bearing surfaces.
4. Pump casing shall be designed for not less than 125 psi working pressure for water service at temperatures up to 225 degrees F. Pump casing shall be provided with tappings for gauge, drain fittings, and neoprene rubber pump connections, flanged.

5. Combination motor bracket/volute cover plate shall maintain alignment of motor to pump casing. Pump shall be designed for mounting with motor/impeller shaft in horizontal configuration with vibration isolation.
6. Pump motor shall have capacity to prevent overloading with pump operating at any point on the characteristic curve and motor shall have drip-proof enclosure.
7. Manufacturers and Products:
   a. Taco; Model 1610.
   b. Bell & Gossett.
   c. Armstrong.

2.4 STRAINERS

A. All strainers, except those installed as integral parts of equipment, shall be the product of a single manufacturer.

B. Y-Type Strainers:

1. Strainers 2 Inches and Smaller shall be iron-body with screwed end connections and screwed plug in blow-off. Strainers shall be rated for 250 pounds minimum SWP. Screens shall be 20 mesh monel.
   a. Keckley: Style B.
   b. Metraflex: Style S.
   c. Mueller: No. 11-FCB.
   d. Spirex Sarco: Type IT.
2. Strainers 2-1/2 Inches and Larger shall be iron-body with 125-pound flanged end connections for installation between 150-pound raised face slip-on weld flanges. Strainers shall be rated for 125-pound minimum SWP. Strainers shall have blow-down connection which shall be provided with full-size gate valve. Strainers shall be equipped with perforated baskets or perforated baskets lined with mesh screens. Strainer screens and baskets shall be stainless steel in accordance with the following:

Size	Perforation Service	Diameter
2-1/2", 3"	Water	.033"
4", 5"	Water	1/8"
6", 8"	Water	1/8"

   a. Strainers shall be:
      1) Keckley: Style D.
      2) Metraflex: Series M1.
      3) Mueller: No. 751 to 12-inch, No. 752 14-inch and larger.
      4) Spirex Sarco: Type C1-125.

2.5 DIELECTRIC ADAPTERS

A. Dielectric adapters shall be the union type for pipes 2 inches in size and smaller and flanged type for pipes 2-1/2 inches in size and larger. Adapters shall have a working pressure of 250 psi for union type and 175 psi for flanged type. The insulating gasket shall have an operating range of 40 degrees F to 240 degrees F and shall limit the galvanic corrosion to a maximum of 1 percent of the short circuit current.

B. Dielectric adapters shall be:

1. Ebco.
2. Crane.
3. Capital.

2.6 THERMOMETERS AND TEST WELLS

A. Thermometers:

1. Thermometers shall be the red-reading mercury-filled adjustable angle type. Thermometers shall be adjustable to any angle through a 180-degree arc and shall be provided with a locking device.
2. Thermometers shall have V-cast aluminum case with baked enamel finish and 9-inch scale. Thermometers shall be provided with separable sockets and where installed on insulated pipes, sockets shall be extension neck type to provide for 2-inch thick insulation.
3. Thermometer scale range shall be:
   a. Hot Water Heating Systems 30 to 300 degrees F with 2-degree scale division.
   b. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.
4. Thermometers shall be:
   a. Weksler Adjust-Angle Series Type AA-5.
   b. Trerice Adjustable Angle Series Type BX.
   c. Weiss Vari-Angle Series Type BS.

B. Test Wells:

1. Test wells shall be for use with engraved stem thermometers. Test wells shall be brass and shall be provided with cap and chain with gasket for sealing when not in use.
2. Wells installed in insulated pipes shall be extension neck type to provide for 2-inch thick insulation. And well shall extend to center of pipe.
3. Test wells shall be:
   a. Weksler.
   b. Trerice.
   c. Weiss.

2.7 PRESSURE GAUGE AND GAUGE COCKS

A. Pressure Gauges:

1. Gauges shall be Grade A, flangeless type and shall have 4-1/2-inch dials, cast aluminum cases, stainless steel rotary gear movements, phosphor bronze bourdon tubes, forged brass rod sockets and tips, 1/2 percent accuracy of scale range, Plexiglas dial covers, safety blow-out disc and 1/4-inch lower connections.
2. Gauges in pump suction line shall be the compound type. Gauges in all other locations and discharge shall be the plain pressure type.
3. Range for pressure gauges shall be selected so that the normal operating point for each application falls in the approximate midpoint of the gauge range. Shop drawings shall indicate ranges.
4. Gauges shall be:
   a. Weksler Type AA1.
   b. Trerice No. 500X Series.
   c. Weiss Series PG.
5. Provide 1/4-inch pressure snubbers where indicated on the Drawings. Material shall be suitable for system fluid and working pressure.

B. Gauge Cocks:

1. Gauge cocks shall be brass level handle type. Gauge cocks shall be:
   a. Weksler Type A.
   b. Trerice No. 880.
   c. Weiss Type LC.

2.8 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.9 FINISHES

A. Manufacturers' standard.

PART 3 EXECUTION

3.1 BALANCING DEVICES

A. Install balancing devices with unrestricted flow and straight pipe for four pipe diameters up and downstream.

B. Install well tappings and fittings for control sensors furnished under other sections.

3.2 VALVE SERVICE

A. Valve types specified hereinbefore shall be used on the systems and services as outlined below and shown on the Drawings.

B. Valves 2 Inches and Smaller:

System	Shut-Off Service	Balancing Service	Check Service
Hot Water	V100	V471	V600
Condensate Drain	V100, V304	NA	V600
Make-Up Water	V100	V200	V600

3.3 ACCESS AND CLEARANCE CONSIDERATIONS

A. Obstructions: Drawings do not attempt to show exact details of piping. Anticipate and work around obstructions.

B. Cover piping installed across aisles or other main access walkways with a protective checkered plate steel ramp, pitched a maximum of 2:12 to allow safe wheeled or foot traffic, and paint with a prime coat and two finish coats of Safety Yellow. Support ramp from the floor, and do not rest ramp directly on pipe.

C. Install specialties with suitable access clearances for maintenance or removal of replaceable components. Provide necessary couplings or flanges to maintain or remove specialties without removing connecting appurtenances.

D. Do not install water or steam piping immediately over or within a 3-foot horizontal clearance of any electrical panel, motor starter, or Environmental Control Panel (ECP). Where piping must be located within these zones, install piping inside a PVC conduit or shield the electrical device to protect it from direct water access.

E. Provide an alternate safe means of access where equipment requiring periodic maintenance cannot be reached by walkways because of substitution of

equipment or interference with ductwork, piping, or other mechanical conflicts resulting from construction. These may include:

1. Overhead platform with stairway or ladder access and safety railings or handholds.
2. Walk-through duct plenums with hinged access doors.
3. Other means as necessary to meet OSHA Standards for safe maintenance procedures.

3.4 CLEANING AND ADJUSTING

A. Cleanup:

1. Thoroughly clean all parts of the installation and remove refuse material at completion of the Work.
2. Check belt-drive tensions and alignments.
3. Lubricate motors and bearings in accordance with manufacturer's service manuals prior to equipment startup.

B. Repair Work: Perform repair work of existing facilities affected by mechanical work performed under this section. Include such items as:

1. Replacement of ceiling tiles or plaster removed or damaged for access to ceiling.
2. Patching walls and ceilings for piping and ductwork penetrations.
3. Repair of concrete or asphalt paving removed for pipe access.
4. Other repairs due to extension and remodeling of existing mechanical systems.

END OF SECTION

SECTION 15550
HEAT GENERATION

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA).
2. Air Moving and Conditioning Association (AMCA): Bulletin 300.
3. American National Standards Institute (ANSI): Z83.4, Direct Gas-Fired Make-Up Air Heaters.
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
   a. 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
   b. 90, Energy Conservation in New Building Design.
5. American Society of Mechanical Engineers (ASME): Code for Pressure Vessels.
6. Factory Mutual (FM).
7. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
8. Industrial Risk Insurers (IRI).
9. National Electrical Manufacturers' Association (NEMA):
   a. MG 1-12.53a, Motors and Generators.
   b. 250.
10. National Fire Protection Association (NFPA):
    a. 54, National Fuel Gas Code.
    b. 70, National Electric Code (NEC).
11. Occupational Safety and Health Act (OSHA).
12. Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA): Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems.
13. Underwriters Laboratories Inc. (UL).
    a. Gas and Oil Equipment Directory.
    b. Electric Heating and Air-Conditioning Directory.

1.2 SUBMITTALS

A. Shop Drawings:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, and electrical schematics, for products specified.

2. Recommended procedures for protection and handling of equipment and materials prior to installation.

B. Contract Closeout Submittals:

1. Operation and maintenance manuals.
2. Manufacturer's Certificate of Proper Installation.

1.3 QUALITY ASSURANCE

A. Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have applied UL listing mark.

PART 2 PRODUCTS

2.1 GENERAL

A. Heating equipment shall have minimum operating efficiencies as specified in Chapter 6 of ASHRAE 90.

B. Boiler Assemblies: Built in accordance with Section IV of ASME Boiler and Pressure Vessel Code.

C. Fans: Sound power level (ref. 10 to 12 watts) at design operating point; ratings based on AMCA Bulletin 300, Setup No. 1.

2.2 GAS-FIRED BOILERS (B-1, B-2)

A. Packaged Gas-Fired Boiler:

1. Power vent fan.
2. Suitable for building heating water system.
3. Natural gas burner and gas train.
4. Cast iron heating section.
5. Control panel with operating and safety controls.
6. Mount on common structural steel frame.
7. See Section 15950 for coordination with HVAC control system.

B. Boiler Cabinet:

1. Insulated with 1-inch thick, 1-pound density fiberglass interior insulation.
2. Metal enclosure finished in manufacturer's standard heat-resistant primer and enamel.

C. Gas Train:

1. FM and IRI approved.

2. Manual main and pilot shutoff valves.
3. Gas pressure regulator.
4. Modulating fire control.
5. High and low gas pressure safety switches.
6. Electronic ignition.

D. Boiler Trim:

1. ASME, Section IV, rated to the boiler pressure with relief valve stamped with HV Code symbol.
2. Manual drain and blowdown valves.
3. Dial pressure and temperature gauges.
4. Manual reset low water cutoff.
5. Manual reset high limit temperature control.
6. Electronic flame safeguard control.
7. Built-in dip tube.

E. Combustion Chamber:

1. Cast iron and water backed.
2. High temperature seal strip gasketing for individual section assemblies.
3. Top cleanout plates.
4. Cast horizontal flue gas collector with exterior smoke collar.

F. Self-Contained Control Panel:

1. Power switch.
2. Terminal strip.
3. Operating and safety controls.
4. Pilot indicator lights for power ON, gas valve ON, flame failure, and low water.
5. Furnish an alarm horn with manual reset button to indicate audible alarms for low water level, high temperature, no flow, and flame failure.
6. Include an auxiliary contact to be used for remote annunciation whenever alarm horn is energized.

G. Manufacturers and Products:

1. Burnham, Minuteman II.
2. Or approved equal.

2.3 BOILER VENT

A. Boiler Vent:

1. UL listed Type PS.
2. Stainless steel jacket.

3. Manufacturer's standard fittings as required.

B. Manufacturers and Product:

1. Heatfab Inc.; SAF-T or CI Vent.
2. Or approved equal.

2.4 COMBUSTION AIR VENT

A. For Gas-Fired Boilers:

1. Stainless steel.
2. Manufacturer's standard fittings as required.

2.5 ACCESSORIES

A. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

PART 3 EXECUTION

3.1 INSTALLATION

A. Boiler:

1. Install in accordance with manufacturer's recommendations.
2. Pipe drains and relief valve discharges to floor drain, terminating with an elbow discharging downward.
3. Flush out boiler and connecting piping prior to initial fill.

B. Gas Vent: Install in accordance with manufacturer's recommendations and requirements of NFPA No. 54.

3.2 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each boiler assisted by manufacturer’s representative as follows:

1. Startup Assistance:
   a. Inspect all gas piping, system piping with accessories, and boiler breeching.

b. Initial startup of boiler, and observe four subsequent starts.
c. Adjust devices in fuel piping circuit.
d. Perform checks on operating and safety controls.
e. Calibrate integral controls, gauges, and thermometers.

B. Performance Test:

1. Conduct on each boiler assisted by manufacturer’s representative.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.

C. Training: Minimum 4 hours' instructional time with GOVERNMENT's personnel reviewing maintenance manuals and showing how each step is to be properly performed.

3.3 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01640, MANUFACTURERS' SERVICES, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of GOVERNMENT's personnel for specified equipment.

END OF SECTION

SECTION 15890
DUCTWORK AND ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE): Handbook.
2. American Society for Testing and Materials (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   c. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   b. 255, Test of Surface Burning Characteristics of Building Materials.
4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. HVAC Duct Construction Standards.
   b. Guidelines for Seismic Restraints of Mechanical Systems.
   c. Fibrous Glass Duct Construction Standards.
   d. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
5. Underwriters Laboratories Inc. (UL):
   a. 181, Standard for Safety Factory-Made Air Ducts and Air Connectors.
   b. 555, Standard for Safety Fire Dampers.
6. Uniform Mechanical Code (UMC) Standards: 10-1, Factory-Made Air Ducts.

1.2 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's data and descriptive literature for duct accessories.

PART 2 PRODUCTS

2.1 DUCTWORK

A. Metal:

1. Material: ASTM A525, G60, 0.0179-inch galvanized steel minimum thickness, except as otherwise indicated.
2. Fabricate in accordance with SMACNA ”HVAC Duct Construction Standards” and UMC 10-1.
3. Furnish either wye or conical tee fittings for round duct takeoffs from round mains, unless otherwise noted on the Drawings.
4. Furnish bellmouth or conical tee fittings for round duct takeoffs from rectangular mains.
5. Furnish 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
6. Duct sizes shown are net air side face-to-face dimensions required.
7. Balancing Dampers: 90 percent unobstructed free area.
8. Furnish seismic restraints for all ductwork systems and sway bracing as described in SMACNA “Guidelines for Seismic Restraints of Mechanical Systems.”

B. Low and Medium Pressure Ductwork:

1. Supply Duct: Minimum + 4-inch W.G. Pressure Class
2. Return and Exhaust Airduct: Minimum – 1-inch W.G. Pressure Gauge.
3. Round or Flat Oval Ductwork:
   a. Spiral Duct Manufacturers:
      1) Glass Insulation Co.; Spiro-Duct.
      2) United Sheet Metal Co.; Spiral Uniseal.
   b. Fittings: Furnish a complete separate fitting for branch takeoffs from spiral ducts.
      1) Branch Takeoffs: Conical laterals, conical tees, or as shown.
      2) Joint Seal Material: Tape and sealer as manufactured by:
         a) Hardcast; Type DT tape and HD-20 adhesive.
         b) United; duct sealer.
      3) Fitting Manufacturers:
         a) Glass Insulation Co.; Type RW.
         b) United Sheet Metal; Uniform.

C. Mechanical Joint Option:

1. Fabricate ducts and joints, including gauge and reinforcing, in accordance with SMACNA Manuals.

2. Construct transverse joints with Ductmate 25/35 duct connector systems, W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system.
3. When using the W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the “W.D.C.I. Heavy “J” and Light “H” Assembly Manual and Duct Construction Standards.”
4. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's “Rectangular Duct Construction Manual for Low, Medium, and High Pressure.”
5. For longitudinal seams, use the Pittsburgh lock seam sealed internally with a permanently elastic sealer such as Ductmate 5511M mastic.
6. Conform to SMACNA Class A sealing requirements.

D. Insulated Flexible Duct:

1. Vinyl vapor barrier jacket.
2. Vinyl-coated fabric interior liner.
3. Insulating Value: R=4 minimum.
4. Suitable for both low and medium pressure use.
5. Attach to duct and terminal device with stainless steel clamps and duct sealer.
6. Length: 6 feet maximum.
7. Meet UL Standard 181-90.
8. Manufacturers and Products:
   a. Flex-Master; Type 3.
   b. Thermaflex; Type M-KE.

E. Exterior Exposed Ductwork:

1. Fabricate from aluminum sheets and line with sound attenuation material.
2. Joints And Seams: Standing-seam type sealed watertight construction.

F. Shower Room and Toilet Room Exhaust Ductwork:

1. Fabricate from aluminum sheets.
2. When shower is not furnished, toilet room exhaust ductwork may be fabricated from galvanized steel sheets.

2.2 DUCT ACCESSORIES

A. Butterfly Manual Dampers:

1. Fabricate from 18-gauge metal of the same material as the ductwork, or galvanized in fiberglass ductboard.
2. Align operating handle with the damper blade.

3. Operator Manufacturer:
   a. Accessible Ductwork: Ventlok; Type 620 or 635.
   b. Accessible Insulated Ductwork: Ventlok; Type 639.
   c. Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

B. Elbows:

1. Rectangular:
   a. Fit square-turn elbows with vane side rails.
   b. Shop fabricate double-blade turning vanes of same material as ductwork.
   c. Fabricate with equal inlet and outlet.
   d. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
   e. Manufacturers and Products:
      1) Elgen; All-Tight.
      2) Duro-Dyne; Type TR.
2. Round: Furnish with centerline radius of 1.5 times duct diameter.

C. Flexible Connections to Noninternally Spring-Isolated Rotating Fan Equipment:

1. Furnish neoprene-coated, fire-resistant glass fabric, with 2-inch minimum clearance between casing and ductwork.
2. Coat outdoor flexible connectors with Hypalon for UV protection.
3. Manufacturers and Products:
   a. Ventfabrics; Ventglas.
   b. Duro-Dyne; Durolon.

D. Ceiling Access Doors:

1. Size: 30 inches by 30 inches.
2. Finish in baked white enamel.
3. Manufacturers:
   a. Inryco Milcor.
   b. Krueger.

E. Duct Inspection Doors:

1. Size: 12-inch by 12-inch with gasketing around periphery.
2. Panels: Hinged, insulated, and fabricated of same material as ductwork or galvanized in fiberglass ductboard.
3. On smaller ductwork furnish a separate size 8-inch by 8-inch access door.

4. Manufacturers:
   a. Ventlok.
   b. Duro-Dyne.

F. Manual Opposed-Blade Balancing Dampers:

1. Furnish externally operated, gang airfoil damper blades.
2. Fabricate from same material as ductwork.
3. Stainless steel or nylon sleeve bearings.
4. Manufacturers and Products:
   a. Ruskin; CD102.
   b. American Warming & Ventilating; Model VC-31.

G. Wall Exhaust Fan Back Pressure Dampers:

1. Extruded 1-1/2-inch aluminum flanged frame.
2. Continuous polyurethane sponge or sill stop.
3. Linked aluminum blades with felt edges and stiffeners.
4. Nylon bearings.
5. Face Grille: 1/2-inch expanded aluminum.
6. Standard mill finish.
7. Manufacturer and Product: American Warming & Ventilating; Model BD-20.

H. Duct Mounted Fire Dampers in Fire Walls with Rating of 2 Hours or Less (FD):

1. NFPA 90A rated for 1-1/2-hour service.
2. Galvanized blades, frame, and mounting angles.
3. Accordion style folded blades.
4. 165 degrees F fusible link.
5. Approved for installation with 2-hour fire rating.
6. Rated, manufactured, tested, and approved in accordance with UL Standard 555.
7. Blades out of the airstream when open.
8. Furnish with sleeved frame for duct connections.
9. Labeled for use in a static mode.
10. Furnish dynamic and horizontal mounted dampers with springs for proper closure.
11. Dampers for Corrosive Service: Type 316 stainless steel.
12. Manufacturers and Products:
    a. Nailor-Hart; Model 0130, Type B.
    b. Ruskin; IBD20, Type B.

I. Ceiling Grille and Diffuser Fire Dampers:

1. UL labeled assembly with frame.
2. Butterfly type blades.
3. 165 degrees F fusible link.
4. Radiation type damper.
5. Manufacturers and Products:
   a. Nailor-Hart; Model 0722 or 0716.
   b. Ruskin; Type CFD Series.

J. Sheet Metal Plenums:

1. Fabricate from minimum 18-gauge metal of the same material as the ductwork.
2. Brace with a frame of the same material for rigidity.
3. Line with sound attenuation material.

K. Louver and Grille Blank-Off Sections:

1. Fabricate from 20-gauge aluminum sheets.
2. Line with sound attenuation material.
3. Shop prime and paint outside face of blank-off section with two coats of flat black exterior paint.

L. Duct Silencers (DS-1)::

1. Fabricate from not less than 22-gauge galvanized steel.
2. Furnish perforated galvanized interior partitions with moisture-resistant mineral fiber carrying an NFPA 255 flame spread Index of 20.
3. Pressure rated airtight at 6 inches water column.
4. Rating: 22-decibel minimum sound reduction in third octave band based upon insertion loss technique of rating at 2,000 fpm face velocity.
5. Size: 3 feet 0 inches long for rectangular.
6. Capacity: 0.15-inch WC pressure drop for rectangular, 0.10 inch WC pressure drop for round.
7. Manufacturers and Products:
   a. Industrial Acoustics Co.; Quiet-Duct, Type S.
   b. Rink; Model A60.

2.3 DUCT INSULATION

A. Flexible Fiberglass Insulation:

1. Thickness: 1-1/2 inches with installed R-value of 4.2 minimum.
2. Density: 3/4 pound per cubic foot.

3. FSK Facing: Maximum vapor transmission rate of 0.02 perm.
4. Flame spread and smoke development rating of 25/50.

B. Manufacturers and Products:

1. Manville; Type 75 FSK.
2. Owens-Corning.

2.4 INTERNAL INSULATION/SOUND ATTENUATION

A. Duct Liner:

1. Rectangular Ducts: 1-inch thick, semirigid fiberglass, with factory coated edges.
2. Round Ducts: 1-inch thick rigid round fiberglass up to 24-inch diameter ducts, and 1-inch semirigid fiberglass for ducts larger than 24-inch diameter.
3. NRC of 0.70 or greater based on Type A mounting.
4. 1.5 pcf density and an R-value of 4 minimum.
5. Flame spread/smoke development rating of 25/50.
6. Attach semirigid liner with fire-resistant adhesive and Duro-Dyne welded pin fasteners with NC-1 nylon stop clips.
7. Adhesive strips at all butt joints unless factory coated edges are used.

B. Manufacturers and Products:

1. Manville; Permacote or Spiracoustic.
2. Owens-Corning; duct liner.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Install sheet metalwork and flexible ductwork in accordance with the latest edition of the SMACNA “HVAC Duct Construction Standards”.
2. Cross-break horizontal surfaces of rectangular metal ducts.
3. Install additional bracing as required to prevent ballooning or breathing.
4. For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape. For exterior ductwork, tape joints with Hardcast outdoor tape and rosin. Tape joints according to the following table:

Pressure Class	Sealing Required
2-inch WC or less	Transverse joints
More than 2-inch WC	Transverse joints and longitudinal seams

5. Seal joints of ductwork in accordance with manufacturer's instructions.
6. Provide balancing dampers for grilles and diffusers in the branch duct as near the main as possible. Add or remove balancing dampers as requested by the air balancing firm for necessary control of air.
7. Make duct size transitions with the maximum inclusive angle of 30 degrees, unless otherwise indicated on the Drawings.
8. Make offsets with maximum angle of 45 degrees.
9. Install seismic restraints on all ductwork systems and sway bracing as described in SMACNA "Guidelines for Seismic Restraints of Mechanical Systems."
10. At ceiling grille and diffuser fire dampers, provide thermal blankets where required by local authorities.

B. Mechanical Joint Option: Install specified transverse duct joints in accordance with manufacturer's instructions and installation manuals.

C. Insulated Flexible Duct:

1. Install, where shown, between branch duct and ceiling diffusers and grilles.
2. Install without sags, kinks, sharp offsets, or elbows.
3. Coat ends on the inside to a depth of 2 inches with duct sealer, slip over the male collar, and clamp in-place.

D. Shower Room and Toilet Room Exhaust Ductwork:

1. Joints and Seams: Seal watertight.
2. Slope branch ducts downward to the grille.

E. Ceiling Access Doors: Install in nonaccessible ceilings below each electric duct heater, booster coil, motorized damper, terminal unit, smoke detector, and fire damper.

F. Fire Dampers: Install 1-1/2-hour rated, unless otherwise indicated, at locations shown and in accordance with SMACNA "Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems."

G. Sound Traps: Install in ducts for air supply units and return fans as shown.

H. Duct Inspection Doors: Install in accordance with manufacturer's instructions at each duct mounted fire damper, duct mounted smoke or ionization detector, electric duct heater, booster coil, humidifier, motorized damper, and sail switch.

I. Insulation:

1. Firmly butt at joints with a maximum allowable compression of 25 percent.
2. Overlap seams a minimum of 2 inches.
3. Finish seams with appropriate 3-inch minimum width pressure sensitive tape or glass fabric and vapor-retardant mastic.
4. For rectangular ducts over 18 inches wide, secure duct wrap to the bottom of the ductwork with mechanical fasteners on 18-inch centers.
5. Apply washers without compressing the insulation.
6. Seal seams, joints, penetrations, and damage to the facing with vapor-retardant mastic.
7. Install on supply ductwork that is not exposed to view.
8. Do not install on ducts that are internally lined.
9. Install on outside air ductwork and combustion air intake pipes.

J. Internal Insulation/Sound Attenuation: Install where shown and in accordance with SMACNA “HVAC Duct Construction Standards” and manufacturer's recommendations.

K. Louver and Grille Blank-Off Sections: Attach airtight to louver or grille and install to allow for easy removal.

END OF SECTION

SECTION 15920
VARIABLE FREQUENCY MOTOR SPEED CONTROLLER

PART 1 GENERAL

1.1 WORK INCLUDED

A. The extent of the variable frequency motor speed controller work is shown on the Drawings and is covered by the requirements of this section.

1.2 QUALITY ASSURANCE

A. Controllers shall have UL or ETL approval. Controller shall comply with all applicable provisions of the current National Electrical Code (NEC).

B. Controller shall have three (3) year warranty.

C. Controllers shall meet the requirements of IEEE 519.

D. Controller manufacturer shall perform a Harmonics Analysis for the entire electrical distribution system.

E. Provide isolation transformers and filters as required to meet IEEE 519.

F. Relevant ANSI standards and local power company standards shall be used to determine transformer fault and impedance values, to be used in the Harmonics Analysis.

1.3 SUBMITTALS

A. Submit general product description, equipment ratings, weight, dimensions, mounting points, interconnecting wiring diagrams and manufacturer's installation instructions.

B. Submit Harmonics Analysis, as required under Quality Assurance above.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Robicon, Reliance, ABB, Magnetek, Toshiba, Graham.

2.2 FABRICATION

A. Variable frequency motor speed controllers shall be provided in NEMA 1 ventilated enclosure for individual wall installation. Controller shall be capable of operating between zero degrees C and 40 degrees C.

B. Fused input shall utilize standard I^2 t type fuses.

C. Variable frequency power and logic unit shall be solid state. Unit shall transform 460 volt, 3-phase, 60 hertz input power into frequency and voltage controlled 3-phase output power suitable to provide positive speed and torque control to standard induction motor. Speed controller shall be stepless. Controller shall not induce voltage line notching back to the utility line.

D. Controller shall be automatically controlled by a grounded electronic (4 to 20 mA, 0-5V DC, 0-10V DC) control signal.

E. Current limit shall be provided at 100 percent of the motor FLA. If current exceeds 100 percent of the motor current, the controller shall slow down the motor. If the current continues to rise, the controller shall shutdown on overcurrent. Current limit shall be adjusted by qualified service personnel for application of the controller to smaller than nameplate motors.

F. Current Limit/Soft Stall Feature: Current limit/soft stall allow continuous operation while in an overload condition. It shall limit the current by slowing down the frequency. The soft stall feature shall be field set and the current limit adjusted to 100 percent of the motor FLA or drive FLA, whichever is smaller.

G. Instantaneous Electric Trip: Automatically safely shut-down motor if:

1. Current exceeds 180 percent of design.
2. Phase-to-phase output short circuit occurs.
3. Phase-to-ground output short circuit occurs.

H. Controller shall restart automatically when input line returns to normal in the event of:

1. Intermittent power outage.
2. Phase loss.
3. Overvoltage shutdown.
4. Overcurrent shutdown.
5. Intermittent voltage spike.

I. Controller shall indicate through the digital display the following fault conditions:

1. Overcurrent.
2. Overvoltage.
3. Overheating.
4. Ground Fault.
5. Short Circuit.
6. Insensitive to incoming power phase.
7. Line-to-line fault protection.
8. Line-to-ground short circuiting and accidental motor grounding protection.
9. Electronic overload protection.
10. Overtemperature protection.

J. No damage shall occur to the controller while under load if an output disconnect is open.

K. Speed Control Standard Features:

1. Operator control interface.
2. HAND/OFF/AUTO operator switch.
3. Drive switch—RUN or STOP command.
4. Panel mounted digital display capable of indicating:
   a. Unit status.
   b. Frequency.
   c. Fault diagnostics.
5. Electronic control follower board (0-5V DC, 0-10V DC, 4 to 20 mA).
6. Minimum/maximum adjustable speeds (minimum speed factory set at 15 Hz; maximum speed factory set at 60 Hz).
7. Manual speed potentiometer control for when the controller is in manual control mode.
8. Automatic restart after power outage and fault occurrences of overcurrent or overvoltage.
9. Linear timed acceleration and deceleration for soft starting/stopping (adjustable from 1 to 300 sec.). Factory set at 50 seconds.
10. Three to 80 Hz controlled speed range (factory set at maximum frequency of 60 Hz).

L. User Interface Board: Terminal connections for:

1. Time clock control.
2. Fire, smoke and freeze detectors.
3. Output terminals for remote frequency meter and ammeter.

2.3 ADJUSTMENTS

A. Controller shall have the following adjustments available via potentiometers located on the faceplate of a single, regulator printed circuit board.

1. Minimum Speed: Zero to maximum.
2. Maximum Speed: 100 percent minimum.
3. Acceleration: 1 to 300 seconds.
4. Deceleration: 1 to 300 seconds.

B. Unit shall accelerate or decelerate in response to contact closures from Dwyer Photohelic Gauge.

1. Units shall have the following features:
   a. Dwyer Model “3002”: Photohelic Gauge(s).
   b. Dwyer Model “302A”: Static pressure tip.
   c. Load shedding terminals: 80 percent maximum speed.

2.4 SERVICE CONDITIONS

A. Controller shall be designed and constructed to operate within the following service conditions:

1. Elevation: 3,300 feet without derating.
2. Ambient Temperature Range: Zero degrees C to 40 degrees C.
3. Atmosphere: Non-condensing relative humidity to 90 percent.
4. A-C Line Voltage Variation: -10 percent to +10 percent.
5. A-C Line Frequency Variation: +2 Hz.

B. Controller shall include:

1. Thermal overload relay.
2. Manual bypass circuit.
3. Line circuit breaker (door interlocked).
4. Control option board.
5. Line reactor.
6. RFI/EMI filter.
7. Fused disconnect switch.

PART 3 EXECUTION

3.1 INSTALLATION

A. Where a disconnect switch is mounted between a variable frequency drive and the motor, the disconnect must have a late make, early break auxiliary contact. This contact shall be wired into the VFD control circuit so that the control circuit is disconnected before the power circuit is broken.

B. Variable frequency motor speed controllers shall be installed in accordance with manufacturer's recommendation.

C. Start-up and testing shall be performed under the direct supervision of a representative of the manufacturer.

D. See Electrical Drawings for installation and power requirement.

END OF SECTION

SECTION 15930
TERMINAL CONTROL UNITS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Moving and Conditioning Association (AMCA): Bulletin 300.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
3. National Electrical Manufacturers Association (NEMA): MG 1-12.53a, Motors and Generators.
4. National Fire Protection Association (NFPA):
   a. 70, National Electric Code (NEC).
   b. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
5. Underwriters Laboratories Inc. (UL): Product Directories.

1.2 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's product information including complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, electrical schematics, and noise and pressure loss data.

B. Quality Control Submittals:

1. Recommended procedures for protection and handling of equipment and materials prior to installation.
2. Manufacturer's Certificate of Conformance for products furnished.

C. Contract Closeout Submittals: Operating and maintenance manuals.

PART 2 PRODUCTS

2.1 VARIABLE AIR VOLUME UNITS

A. Construction:

1. Single duct reheat terminal control unit with pressure independent automatic damper operation.

2. Cabinet Materials: 22-gauge, zinc-coated steel with factory applied enamel paint finish, or galvanized sheet steel.
3. Insulate internal surfaces acoustically and thermally with 1/2-inch thick, 2-pound density, matte-faced insulation.
4. Automatic Dampers: Factory install and test.
5. Access panel in bottom panel.

B. Hot Water Heating Coil:

1. Coil:
   a. Aluminum plate fin type with full fin collars for accurate spacing and maximum fin-tube contact.
   b. Female sweat connections.
2. Tubes: 5/8-inch outside diameter seamless copper expanded into the fin collar for permanent fin-tube bond.

C. Controls:

1. Adjustable for a maximum reduction of air volume to 25 percent of the design air volume in cooling mode. See schedule for minimum air volume in heating mode.
2. Factory install damper operators furnished under Section 15950, HVAC CONTROLS.
3. Capable of modulating, in sequence, the damper and the hot water coil valve in response to the space thermostat.

D. Manufacturers and Products: Design based on the listed manufacturer and products; products of other manufacturers shall be considered in accordance with Section 01600:

1. Trane; VCWE.

2.2 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Leak test heating coils underwater with 250 psig air; no leaks allowed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Support terminal control units from structure with galvanized steel straps or threaded rods from four corners of the unit.

B. Provide four duct diameters of straight duct length to the air terminal unit inlet to allow for proper control, unless otherwise allowed by the unit manufacturer.

C. Duct Connections: As specified in Section 15890, DUCTWORK AND ACCESSORIES.

D. Wiring Connections: As specified in Section 15950, HVAC CONTROLS.

END OF SECTION

SECTION 15940
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Underwriters Laboratories Inc. (UL): Product Directories.

1.2 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's data and descriptive literature for products specified.
2. Furnish the following information for each type of diffuser, register, and grille furnished.
   a. NC sound data.
   b. Static pressure loss data.
   c. Throw data.

PART 2 PRODUCTS

2.1 CEILING DIFFUSERS

A. Square Ceiling Diffusers (CD):

1. Welded steel construction with baked white enamel finish.
2. Concealed adjustable deflector blades.
3. Removeable perforated faceplate.
4. Round neck.
5. Continuous sponge rubber gasket at face flange.
6. Manufacturers and Products:
   a. Carnes; Type SPAB (steel).

B. Linear Diffusers (LD):

1. Rectangular aluminum construction.
2. Extruded 1-inch flat slotted frame with concealed fasteners.
3. Concealed swing type adjustable deflector blades.
4. Three 3/4 -inch slots.
5. Continuous sponge rubber gasket at face flange.
6. Baked white enamel finish.
7. Flat black deflector blade.
8. Furnish with 1/2-inch internally lined plenum with side inlet duct collar.

9. Manufacturers and Products:
   a. Krueger; Model 1900.
   b. Carnes; Model CH Channel-Aire.

2.2 SUPPLY GRILLES AND REGISTERS

A. Ceiling and Wall Supply Registers (CSR, WSR):

1. Rectangular aluminum construction.
2. Individually adjustable horizontal face and vertical rear louver fins.
3. Gang-operated opposed-blade horizontal volume control damper.
4. Continuous sponge rubber gasket at face flange.
5. 1-inch flat aluminum frame.
6. Prime coat finish.
7. Manufacturers and Products:
   a. Krueger; Model 5880H-OBD.
   b. Carnes; Type RNDAH.

B. Ceiling and Wall Return and Exhaust Registers (CR, WR):

1. Rectangular aluminum construction.
2. Fixed horizontal louvers set at 35 to 45 degrees.
3. Gang-operated opposed-blade volume control damper.
4. 1-inch flat aluminum frame.
5. Baked white enamel finish for ceiling registers and prime coat finish for wall registers.
6. Manufacturers and Products:
   a. Krueger; Model S580H-OBD.
   b. Carnes; Type RNAAH.

C. Perforated Ceiling Return and Exhaust Grilles (PCG):

1. Welded steel construction.
2. Removable perforated faceplate.
3. Size to fit into standard lay-in tee-bar ceiling.
4. Baked white enamel faceplate.
5. Flat black interior.
6. Round neck.
7. Manufacturers and Products:
   a. Krueger; Model 6590.
   b. Carnes; Type SPRB.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

B. Provide appropriate frame to adapt to mounting surface.

END OF SECTION

SECTION 15950
HVAC CONTROLS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): B19.3, Safety Standard for Compressors for Process Industries.
2. International Conference of Building Officials (ICBO): Uniform Building Code (UBC).
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
4. National Fire Protection Association (NFPA): 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
5. Underwriters Laboratories Inc. (UL): Electrical Construction Materials Directory.

1.2 SYSTEM DESCRIPTION

A. Description:

1. Control Type: Design and provide electric system with supplementary electric or electronic devices as required.

B. Performance Requirements: Design system and equipment to perform under the following conditions:

1. Temperature, Ambient: Summer maximum 94 DB/75 WB degrees F; winter minimum 1 DB degrees F, based on ASHRAE 99 percent design outdoor temperature.
2. Temperature, Indoor:
   a. Air-Conditioned Areas: Summer maximum 75 degrees F; winter minimum 72 degrees F, based on ASHRAE 1 percent design outdoor temperature.
3. Altitude: 619 feet above MSL.

C. Design Requirements:

1. Provide controls necessary for the entire system to have fail-safe operation.

2. Interface controls properly with factory supplied components of the mechanical systems. Coordinate special control interfacing requirements.
3. For equipment specified that requires special interfacing with the control system, provide equipment with integral controls necessary to operate properly with this control system, or provide accessory devices required for operation of the total mechanical system.
4. Control Components:
   a. Field or computer adjustable to actual set point, ranges; adjustable to other settings that will provide proper operation of the entire control system.
   b. Of proper sensitivities to preclude cycling and to maintain control points adequately close to set points for acceptable offset.
5. Coordinate with Section 15960, ENERGY MANAGEMENT AND CONTROL SYSTEMS.

1.3 SUBMITTALS

A. Shop Drawings:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics, for all control system components.
2. Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 11 inches by 17 inches.
3. Complete drawings and schematics of proposed control system, including panel power requirements.

B. Quality Control Submittals:

1. Recommended procedures for protection and handling of equipment and materials prior to installation.
2. Manufacturer's Certificate of Conformance.
3. Manufacturer's Certificate of Proper Installation.
4. Experience and qualifications of Controls Supplier.
5. Operation and maintenance manual.
6. Detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt the arrangement or details shown to the equipment and materials furnished.

C. Contract Closeout Submittals:

1. Record Documents: Complete as-built wiring diagrams.
2. Recommended spare parts list:

a. Quantities and replacement frequency.
b. Current list prices, valid for 90 days after Substantial Completion.
c. Availability and nearest distributor.

3. Record of system adjustments.

1.4 QUALITY ASSURANCE

A. Qualifications of Controls Supplier: Capable of furnishing factory trained technicians, competent to provide instruction, routine maintenance, and emergency service on the site within 48 hours after receipt of request.

B. Regulatory Requirements: Comply with industry, society, or association standards as specified, and with applicable laws or regulations.

C. Labeling: All electrical materials, devices, appliances, and equipment used shall be indicated as acceptable by the established standards of the Underwriters Laboratories, Inc. Indication shall be by a valid label affixed to the item. Panels which consist of multiple components shall be listed and labeled as a unit in addition to any other requirements.

D. All electrical wiring shall be performed in accordance with the requirements of the National Electric code.

E. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specifications requirements.

F. Install system using competent workmen who are fully trained in the installation of temperature control equipment.

1.5 MAINTENANCE

A. Maintenance Service: Furnish a draft maintenance agreement, prepared and signed by the Controls Supplier, to provide the necessary preventive maintenance to keep the various control systems in proper working condition. Fully describe the maintenance work to be performed and estimate cost of the maintenance during the 1-year correction period and the subsequent year.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of: Invensys Environmental Controls.

B. No “or-equal” or substitute products will be considered.

2.2 GENERAL

A. Control Type: Microprocessor-based electronic and electro-mechanical devices as required.

B. Nameplates: Furnish in engraved laminated plastic to be installed adjacent to the following control devices, and for equipment whose function is not readily apparent.

1. Night low limit thermostats.
2. Manual override timers.
3. START/STOP switches.
4. Emergency STOP switches.
5. Special purpose devices.
6. Do not mark room thermostats.

C. Provide all components of the control system from the same manufacturer, unless a specific manufacturer is specified.

2.3 ELECTRIC SYSTEM COMPONENTS

A. Conductors: Plastic-covered, not less than 18-gauge. Control voltage shall not exceed 30 volts, except in starter pilot circuits.

B. Furnish components from the same manufacturer, unless a specific manufacturer is specified.

C. Electrical products and execution required to complete the work under this section shall conform to the applicable requirements of Division 16, ELECTRICAL.

D. Labeling: All electrical materials, devices, appliances, and equipment used shall be indicated as acceptable by the established standards of Underwriters Laboratories, Inc. Indication shall be by a valid label affixed to the item.

2.4 DAMPERS AND DAMPER OPERATORS

A. Dampers:

1. Furnish automatic control dampers except those that are specified to be furnished with the equipment.
2. Fabricate dampers of 22-gauge minimum galvanized steel.
3. Furnish 6-inch maximum blade width and 50-inch maximum blade length per section.

4. Furnish opposed-blade type for proportional action, and parallel-blade type for two-position action.
5. Set blades in a suitable channel frame.
6. Blade shafts shall turn in oil-impregnated sintered bronze bearings or bearing grade nylon.
7. Where outside air, exhaust dampers, and motorized louvers are specified, furnish damper linkage with slotted damper crank arm, adjusted so that damper is closed with the motor shaft retracted and at the minimum flow position with the motor shaft fully extended.

B. Damper Operators Electric:

1. For motorized dampers and louvers.
2. Fully proportioning unless otherwise specified.
3. With ample power to overcome friction of damper linkage and air pressure acting on the damper blades.
4. Mounted to outside the airstream where possible.
5. Furnished with external adjustable stops to limit the stroke.
6. Operators on modulating dampers that are to be sequenced with other control devices shall have a pilot positioner of the full relay type and interconnecting linkage to provide mechanical feedback that will accurately position and control the damper.
7. Sized to provide modulating or two-position action as required.
8. Intake and exhaust dampers to close and return dampers to open on control failure, or furnish as indicated on the Drawings.

2.5 AUTOMATIC CONTROL VALVES

A. Fully proportioning with modulating plugs for equal percentage of linear flow characteristics.

B. Sized for a maximum pressure drop of 3 psi.

C. Valve Body and Trim: Sufficient to handle system pressure and temperature.

D. Valves 1/2 Inch Through 2 Inches:

1. Constructed with a cast brass body and screwed ends.
2. Trim: Removable cage providing valve plug guiding throughout the entire travel range.
3. Stainless steel stem.
4. Removable bonnet, cage, stem, and plug assembly.

E. Valves 2-1/2 Inches and Larger:

1. Cast iron body and flanged connections.

2. Trim: Removable cage providing valve plug guiding throughout the entire travel range.
3. Stainless steel stem.
4. Removable bonnet, cage, stem, and plug assembly.

F. Valve Actuators:

1. Have sufficient power for intended duty.
2. Be capable of closing against differential pressures to be encountered.
3. Constructed and piped to fail to full heating upon loss of control signal.
4. Capable of being sequenced either with other valves or other pneumatically actuated devices where required by sequence of operation.
   a. Where such sequencing is required, the actual spring range, when adjusted for spring shift, shall allow no overlapping to occur.
   b. In the event that spring shift causes an overlap, furnish a pilot positioning operator.
5. Cast aluminum body with spring return piston operated by synthetic rubber diaphragm.

2.6 INSTRUMENTATION

A. Time Clock:

1. Electronic 7-day programmable type.
2. 8-hour battery backup feature.
3. Mount inside the DDCP.
4. Manufacturers and Products:
   a. Paragon.
   b. Omron.

B. Duct Mounted Ionization Detection:

1. Furnish duct mounted 120V ac ionization detectors suitable for airstream sensing.
2. Furnish with reset button or key switch.
3. Include mounting bracket for installation on the ductwork.
4. Duct mounted smoke detectors shall be provided by the Mechanical Contractor.
5. Power wiring and interlock wiring to shut down the air handling equipment shall be provided by the controls supplier.
6. Provide normally open, double pole, double throw output contacts, rated 3A, 3OV DC.
7. Manufacturers and Products:
   a. BRK Electronics; Model DH1851AC.

b. Pyrotronics Pyr-Alarm; Model.

C. Carbon Monoxide Sensor:

1. Provide sensor to detect presence of carbon monoxide gas.
2. Sensor shall be temperature and humidity compensated to minimize false alarms.
3. Sensor shall utilize solid state elements.
4. Unit performance shall be:
   a. Stability: ± 1 percent.
   b. Repeatability: Less than ± 2 percent full scale.
   c. Error per degree C: 0.3 ppm.
   d. Error from 10 percent to 99 percent RH: 0.2 ppm.
   e. Response Time: 150 seconds for 90 percent of step change.
   f. Noise: ± 1 percent of full scale.
   g. Linearity: Linearized output.
5. Unit operating characteristics shall be:
   a. Indication:
      1) Green (power).
      2) Red (sensor board malfunction).
   b. Sensor Life: 3 years or longer expected.
   c. Sensor Fail: Output goes below 2 mA.
   d. Sensor Power Input: 24V dc power; typical plus or minus 5 percent per 150 mA (max. 200 mA).
   e. Sensor Signal Output: 4 to 20 mA dc into 750 ohm maximum.
6. Type shall be MSA Instruments, Catalog No. 208167, or approved equal.

2.7 DIRECT DIGITAL CONTROL PANELS (DDCP)

A. DDCP Contents:

1. Microprocessor control modules, electronic indication relays, control switches, transformers, pilot lights, alarm lights, and other accessories necessary for the particular system.
2. Provide at locations shown on the Drawings for convenient control of entire buildings.
3. Components shall be UL listed.

B. DDCP Construction:

1. NEMA 250 Type 1 rated except where indicated otherwise.
2. Metal enclosure to accommodate secure conduit fittings and protect against electrical transients.
3. Hinged front door with locking handle.

4. Mount all lights and switches in full view with the panel door closed.
5. Provide a flashing alarm light, visible from the room entrance, to call attention to any alarm event.
6. Identify front panel mounted devices and DDCP by engraved laminated plastic nameplates with white letters on black background.
7. Panels which consist of multiple components shall be listed and labeled as a unit.
8. All wiring in DDCP shall be plenum rated.

C. Control Devices:

1. Mount inside the DDCP.
2. Prewired internally.
3. Terminate all wires leaving the DDCP at separately numbered terminal strips (one terminal pair per circuit).
4. Provide individual connectors for every item of mechanical equipment, all integral and remote pilot lights, and other devices described for each panel.
5. Refer to Electrical Drawings for power and control circuit requirements.
6. Identify all wires by color coding or numerical tags at both ends.
7. Wire control devices without splices to the terminal strip.
8. Provide integral circuit protection for all panel mounted control devices.
9. Supply each DDCP with a single 120-volt, 20-amp feeder under Division 16, ELECTRICAL.

D. Terminal Blocks:

1. One-piece molded plastic blocks with screw-type terminals and barriers rated for 300 volts.
2. Double sided and supplied with removable covers to prevent accidental contact with live circuits.
3. Provide permanent, legible identification, clearly visible with the protective cover removed.
4. Terminate wires at the terminal blocks with crimp type, preinsulated, ring-tongue lugs.
5. Size lugs for the terminal block screws and for the number and size of the wires terminated. Terminals for control wiring from the motor starters shall accommodate 14-gage conductors.
6. Provide screwdriver access for blade width of a minimum of 3/16-inch or Klein 601 series screwdrivers. Terminals requiring the use of special screwdrivers are not acceptable.

E. Miscellaneous Accessories:

1. Furnish spare lamps for each type used. The quantity of spares shall be 10 percent of the amount installed, rounded up to the next standard pack quantity. Store securely inside the panel.
2. Furnish panel as-built electrical wiring diagrams, secured to the inside of the panel door, or enclosed in plastic jackets placed inside each panel.
3. Provide plastic or stick-on labels on all interior control devices to identify them in conjunction with the wiring and piping schematics.
4. Description shall include the device and its normal operation, such as "CR-9, close 55 degrees F ambient."

2.8 MISCELLANEOUS ACCESSORIES

A. Furnish electric relays and coordinate with the supplier of magnetic starters for the auxiliary contact requirements.

B. Electrical Control Devices: Type to meet current, voltage, and switching requirement of the particular application.

C. Relays: Furnished with 24V ac coils and contacts rated at 10 amps minimum.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

A. Refer to the Electrical Drawings for identification of NEC area classifications. Provide control equipment and wiring within classified spaces in accordance with NFPA 70.

B. All controls requiring a manual reset or other user function shall be readily accessible.

C. Mount DDCPs level and securely to wall or column. Verify that adequate clearance is provided to allow for full front panel swing.

D. Coordinate mounting height of room temperature sensors with the COTR/CM and Electrical Contractor. Sensors shall generally be the same height as light switches.

3.2 WIRING INSTALLATION

A. Run control and interlock wiring in conduit sized to suit the number, type, and size of conductors as specified in Section 16120, CONDUCTORS. Install control and interlock wiring in conduit separate from power wiring

B. Provide complete electric wire, cable, fittings, and conduit associated with the systems specified in this section, in accordance with the requirements of NFPA 70, National Electrical Code (NEC).

C. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings, and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 16 sections of these Specifications. The term "control wiring" includes providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices.

D. Install control wiring system in conduit for electric/electronic control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed.

E. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.

F. Properly support and run wiring in a neat manner. Run wiring parallel to, or at right angles to, the building structure. Wiring within enclosure shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

3.3 FIELD QUALITY CONTROL

A. Performance Testing of Installed Control System:

1. Functional Test: Prior to plant startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01640, MANUFACTURER'S SERVICES and Section 01650, STARTING OF SYSTEMS/COMMISSIONING.

3.4 ADJUSTING AND CALIBRATING

A. The installation, operation, and adjustment of the control system is the responsibility of the Controls Supplier.

1. At the completion of the job, thoroughly check out the entire control system by simulating each control function to verify that the system performs in accordance with the Specifications.
2. Advise THE GOVERNMENT and COTR/CM accordingly in writing.
3. Upon notice from the COTR/CM, demonstrate successful operation of all modes of all HVAC equipment to the COTR/CM.

B. The entire control system shall be adjusted and calibrated by the Controls Supplier's qualified representative. Obtain approval of the qualifications of the proposed representative prior to making any control system adjustments.

C. Calibrate all control devices at time of installation to ensure measuring and reading accuracy.

D. Prepare a complete record of system adjustments for each air supply system and miscellaneous control system. Indicate any deviations from the specified temperatures. Include a copy of the completed record in each copy of the operation and maintenance instructions.

3.5 SEQUENCE OF OPERATION

A. Air Cooled Condensing Unit (ACCU-1) Operation:

1. Condensing Unit Start/Stop: The condensing unit shall be started and stopped either manually or through time schedule by EMCS.
2. Condensing Unit Failure: If the condensing unit fails, the EMCS shall send an alarm.
3. Condensing Unit Capacity: EMCS shall calculate the tonnage (from KW consumption by the condensing unit) of the cooling system and shall be available at all time for operator use.
4. DDC Control Point List:

Type	Description	Alarm	Comment
DO	Condensing Unit Start/Stop	(F)	
AI	Condensing Unit Amperage		
AI	Evaporator Refrigerant Pressure	(H) (L)	
AI	Condenser Refrigerant Pressure	(H) (L)	
*Alarm Key: (H)—High, (L)—Low, (F)—Fail, (S)—Shutdown			

B. Boiler (B-1 and B-2) Operation:

1. Hot water pump P-1 or P-2 shall start through the EMCS. The boiler shall be energized and upon proof of flow, the boiler packaged controls shall modulate the burner as required to maintain a discharge water temperature of 190 degrees F. The boilers shall operate simultaneously and continuously. If either boiler fails, the EMCS shall sound an alarm to alert the operator.

2. Hot Water Reset Control: The boiler packaged controls shall reset the hot water supply temperature setpoint(s) linearly based on outdoor air temperature. Minimum hot water supply temperature shall be 160°F.
3. DDC Control Point List:

Type	Description	Alarm	Comment
DO	Boiler 1 Start/Stop (S/S)		
DO	Boiler 2 Start/Stop (S/S)		
AI	Boiler 1 Status (FL)	(F)	Flow Meter
AI	Boiler 2 Status (FL)	(F)	Flow Meter
AI	Loop Return Temp (T)	(H) (L)	Hi Limit: 200 deg F Lo Limit: 140 deg F
AO	Boiler 1 Setpoint (T)		190 deg F
AO	Boiler 2 Setpoint (T)		190 deg F
AO	Hot Water Loop Setpoint Adj (T)		190 deg F
AI	Outside Air Temperature (T)		
*Alarm Key: (H)—High, (L)—Low, (F)—Fail, (S)—Shutdown			

C. Hot Water Pump (P-1 and P-2) Operation:

1. The EMCS operator shall designate the lead and standby pumps. If the lead pump fails as sensed by the current switch at the pump motor, the EMCS shall start the standby pump. When switching between lead and standby pump occur, the second pump shall start before the operating pump is stopped.
2. DDC Control Point List (for each pump):

Type	Description	Alarm*	Comment
DO	Pump Start/Stop (S/S)	(F)	
DO	Pump Run Status		
AI	Hot Water Flow		
AI	Hot Water Temperature		
*Alarm Key: (H)—High, (L)—Low, (F)—Fail, (S)—Shutdown			

D. AHU-1 Operation:

1. General: This sequence describes the operation of a variable air volume (VAV) air handling unit (AHU) that supplies air to variable air volume terminal units. Unit control is by EMCS. The AHU has a return air fan.

2. Unoccupied: When the EMCS indexes the building for unoccupied operation, the supply and return air fans shall be de-energized, and the outside air and return air dampers shall be modulated closed.
3. Occupied: When the EMCS indexes the building for occupied operation, the minimum outside air and return air dampers shall be opened, the supply fan and the return fan shall be energized and shall run continuously. Unit operation shall be as described in Fan Control and Temperature Control below.
4. Night Setback (Summer): During unoccupied operation, should the average space temperature rise above 82 degrees F, the unit supply and return air fans shall be energized and the unit shall operate as described under Temperature Control until the average space temperature drops to 80 degrees F (adjustable), at which time the supply and return fans shall be de-energized. During night set up operation, the unit outside air damper (min & max) shall remain closed.
5. Night Setback (Winter): During unoccupied operation, should the average space temperature fall below 58 degrees F (adjustable) the unit supply and return air fans shall be energized and the unit return air damper shall be opened. Space heating shall be provided by activation of terminal unit heating coils. When the average space temperature rises above 60 degrees F, the supply fan shall be de-energized. During night setback operation, the outside air dampers shall remain closed.
6. Morning Warm-up Mode: Operation shall be as for Night Setback mode, except that the required average space temperature shall be increased to 70 degrees F (adjustable). Morning warm-up mode shall be initiated 1 hour (adjustable) before occupied operation.
7. Supply Fan Operation: In response to a signal from an electronic static pressure sensor, the variable frequency drive (VFD) shall modulate the supply fan speed, in order to maintain a constant duct static pressure of 1.0-inch WG (adjustable).
8. Return Fan Operation: When the return fan VFD is started, the EMCS shall control the speed of the VFD to maintain the constant differential CFM between the supply fan and the return fan. As the differential CFM increases above the differential CFM setpoint, the return fan speed shall increase. When the differential CFM decreases below the differential CFM setpoint, the return fan speed shall decrease. The differential CFM setpoint shall be initially set at the minimum outdoor air CFM shown in the Air Handling Unit Schedule on Mechanical Drawings.
9. High Duct Pressure Shutdown: Should the AHU discharge pressure exceed 5.0-inch WG (adjustable), the EMCS shall de-energize the supply and return fans, to prevent duct rupture.
10. Fan Shutdown: Should products of combustion be detected by duct mounted smoke detectors associated with this unit, the supply and return

air fans shall be de-energized, and the outside air damper shall be closed.

11. Freeze Detection: Should the heating coil discharge air temperature drop below 32 degrees F, the BAS shall override the outside air damper control to allow mixing of return air to raise the coil discharge air temperature, in order to prevent coil freeze up. Upon a continued temperature below 32 degrees F, the BAS shall de-energize the unit.
12. Ventilation Control:
    a. General: When the calculated outdoor enthalpy is higher than the calculated return air enthalpy, ventilation control shall be as described under paragraph Minimum Ventilation Cycle. Should the calculated outdoor enthalpy fall below 95 percent of the calculated return air enthalpy, ventilation control shall be as described under paragraph Economizer Cycle.
    b. Minimum Ventilation Cycle: When the Minimum Ventilation Cycle is enabled, the economizer damper shall be closed, and the minimum ventilation damper and return damper shall modulate in sequence to maintain the minimum ventilation flow rate set point, as scheduled (adjustable).
    c. Economizer Cycle: When the economizer cycle is enabled, the minimum ventilation damper shall open fully and the economizer damper shall modulate in sequence with the return air damper, in order to maintain the mixed air temperature set point at 55 degrees F (adjustable). Should the mixed air temperature fall below 53 degrees F (adjustable) or rise above 57 degrees F (adjustable), the economizer damper shall modulate closed and ventilation shall proceed as described under paragraph Minimum Ventilation Cycle. The economizer cycle shall not be allowed to re-enable for a minimum period of 5 minutes (adjustable).
13. Temperature Control:
    a. Cooling Control:
        1) Economizer Mode: In the economizer mode, the EMCS shall operate the cooling system in sequence with the dampers to maintain a discharge temperature of 55 degrees F (adjustable).
        2) Mechanical Cooling Mode: In this mode, the EMCS shall operate the cooling system to maintain a discharge air temperature of 55 degrees F (adjustable).
    b. Heating Control:
        1) Occupied Mode: In this mode, the EMCS shall modulate the heating coil valve in sequence with the dampers to maintain a discharge air temperature of 55 degrees F (adjustable). The discharge air temperature shall reset if all VAV boxes

are at minimum airflow and upon a rise in return air temperature.

2) Unoccupied/Warm-up Modes: In these modes, if the fans are running, the heating coil valve shall modulate to maintain the discharge temperature of 55 degrees F (adjustable).

14. DDC Control Point List:

Type	Description	Alarm	Comment
DO	Supply Fan Start/Stop (S/S)		
AO	Supply Fan Motor Speed Control (VFD)	(F)	
DI	Supply Fan (VFD) Run Status	(F)	
AI	Duct Static Pressure (DSP)	(L) (H)	
AI	Duct Discharge Pressure (DSP)	(S)	Shutdown Fan
DI	Duct Smoke Detector (SD)	(S)	Number shown on Drawings
DO	Cooling Coil Control Valve		
AO	Reheat Coil Control Valve		
AI	Unit Discharge Temp (T)	(H) (L)	
AI	Filter Status (DP)	(H)	
AO	Minimum Outside Damper Control		
AO	Maximum Outside Air Damper		
AO	Return Air Damper Control		
AI	Freeze Stat (FRZ)	(L) (S)	
AI	Outside Air Temperature (T)		
AI	Return Air Temperature (T)		
AI	Return Air Relative Humidity (RH)		
AI	Mixed Air Temperature (T)	(H)(L)	
AO	Return Fan (VFD) Speed Control	(F)	
DI	Return Fan (VFD) Run Status	(F)	
AO	Relief Air Damper Control		
*Alarm Key: (H)—High, (L)—Low, (F)—Fail, (S)—Shutdown.			

E. Variable Air Volume, Hot Water Heat, (Typical):

1. General: This control sequence describes the operation of variable volume terminal units (VTU), which distribute air from VAV AHU-1 to their respective spaces. Unit control is by EMCS.
2. Unoccupied: When the EMCS indexes the building for unoccupied operation, the VTU primary air damper shall be closed.

3. Occupied: When the EMCS indexes the building for occupied operation, the VTU primary air damper shall be opened to its minimum position. Unit operation shall be as described under temperature control below.
4. Unoccupied Override: An override switch, provided on each room temperature sensor, shall initiate override of the Unoccupied mode to the Occupied mode, when activated by the occupant. Duration of override shall be for one hour (software adjustable).
5. Night Setback (Summer): During unoccupied operation, should the EMCS initiate night setback mode, the VTU primary air damper shall be opened as required to maintain a space temperature of 80 degrees F. When the night setback sequence has concluded, the VTU primary air damper shall be closed.
6. Night Setback (Winter): During Unoccupied operation, should the EMCS initiate night setback mode, the VTU primary air damper shall be opened and the hot water heating coil shall modulate open to maintain a space temperature of 60 degrees F (adjustable). When the night setback sequence has concluded, the VTU supply air damper shall be closed.
7. Temperature Control: The ECMS shall modulate the VTU primary air damper open as the space sensor senses a need for cooling, to offset room load at a space temperature of 78 degrees F (adjustable). As the space sensor senses a need for reduced cooling, the primary air damper shall be modulated closed to its minimum position.
8. Temperature Control (Heating): The ECMS shall modulate the heating water (HW) coil ACV in response to a signal from the space temperature sensor, in order to maintain a space temperature of 70 degrees F (adjustable). Should the space temperature rise above 73 degrees F, the ECMS shall modulate the hot water coil to the fully closed position. Should the space temperature continue to rise, the unit shall operate as described under Temperature Control (Cooling).

9. Control Points:

Type	Description	Comment	Alarm*
AO	Heating Coil Control Valve (ACV)		
AI	Space Temperature (T)		(H)(L)
AO	Primary Air Damper (M)		
AI	Primary Air Flow Rate (CFM)		
AI	Discharge Air Temperature		
*Alarm Key: (H)—High, (L)—Low, (F)—Fail, (S)—Shutdown			

F. Exhaust Fan (EF-1):

1. General: This sequence describes the operation of the restroom exhaust fan, controlled by the EMCS.
2. Off: When AHU-1 is de-energized, the fan shall be de-energized.
3. On: When AHU-1 is energized, the fan shall be energized.
4. System Interlocks: EF-1 shall be interlocked with AHU-1 supply fan.
5. DDC Control Points:

Type	Description	Comment	Alarm*
DO	Fan Start/Stop (S/S)		(F)
DI	Fan Run Status		
*Alarm Key: (H)—High, (L)—Low, (F)—Fail, (S)—Shutdown			

3.6 MANUFACTURER'S FIELD SERVICE

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite for the minimum number of person-days listed for the services hereunder, travel time excluded:

1. 1 person-day for installation assistance, inspection, and certification of the installation. Provide certificate.
2. 1 person-day for functional and performance testing and test certification.
3. As needed (1 person-day minimum) for pre-startup classroom or jobsite training.

B. Provide sufficient training of the GOVERNMENT's personnel to enable them to operate all HVAC equipment in all available modes, to adjust set points, and to interpret alarm signals. Training sessions shall be well prepared in advance, and arranged for clear, effective transfer of information in minimum time. The training shall be at such times and at such locations as requested by the GOVERNMENT.

C. See Section 01640, MANUFACTURER'S SERVICES.

3.7 MANUFACTURER'S CERTIFICATE(S)

A. Provide manufacturer's certificate(s) in accordance with Section 01640, MANUFACTURERS' SERVICES, of Division 1, GENERAL REQUIREMENTS

END OF SECTION

SECTION 15960
ENERGY MANAGEMENT AND CONTROL SYSTEMS (EMCS)

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
3. Underwriters Laboratories Inc. (UL): 200B.

1.2 WORK INCLUDED

A. This section covers the requirements for an electronic direct digital control (DDC) energy management and control system (EMCS).

B. This section is a supplement to Section 15950, HVAC CONTROLS, of these specifications, and shall include all provisions of same.

1.3 DEFINITIONS

A. Abbreviations Used in this Section:

1. AHDC, Air Handler Digital Controller.
2. BAS LAN, Building Automation System Local Area Network.
3. BAS-WS, Operator Workstation.
4. CCS, Central Control Station.
5. CHS, Central Host Station.
6. GCM, Standalone Digital Controller.
7. GDC, Gateway Digital Controller.
8. GP, Graphical Programmer.
9. HHOT, Hand Held Operator Terminal.
10. LCM, Mechanical System Digital Controller.
11. LIDC, Lighting Interface Digital Controller.
12. RPTR, Communications Repeater.
13. TI, Telephone Interface.
14. UDC, Unitary Digital Controller.
15. VAVDC, Variable Air Volume Digital Controller.

1.4 SYSTEM DESCRIPTION

A. Description: Design and provide a complete electronic direct digital temperature control system comprising five levels of control devices.

1. First Level: System component devices including but not limited to electronic sensors, valves, actuators, switches, relays, and transducers.
2. Second Level: Dedicated zone controllers for VAV box controls.
3. Third Level: Local controllers for control of large primary mechanical systems such as air handling systems and heating hot water systems.
4. Fourth Level: System controllers that are used for high level global programming functions and system networking.
5. Fifth Level: Hand-held operator terminals (HHOTs).

B. Standalone System: The EMCS shall be installed as a standalone system for the building. The EMCS shall not require a central computer unit for system operation.

C. The EMCS system shall:

1. Be modular in nature to support expansion in capacity and function.
2. Support “open architecture” or open communication links to systems provided by other manufacturers.
3. Support ASHRAE/ANSI BACnet standards as they evolve.

D. The EMCS shall include a modem for remote communication.

E. Design Requirements:

1. Provide controls necessary for the entire system to have fail-safe operation.
2. Interface controls properly with factory supplied components of the mechanical systems. Coordinate special control interfacing requirements.
3. For equipment specified that requires special interfacing with the control system, provide equipment with integral controls necessary to operate properly with this control system, or provide accessory devices required for operation of the total mechanical system.
4. Control Components:
   a. Field or computer adjustable to actual setpoint, ranges; adjustable to other settings that will provide proper operation of the entire control system.
   b. Of proper sensitivities to preclude cycling and to maintain control points adequately close to setpoints for acceptable offset.
5. Coordinate with Section 15950, HVAC CONTROLS.

1.5 SUBMITTALS

A. Shop Drawings:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature including make, model, dimensions, weight of equipment, and electrical schematics, for control system components.
2. Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 11 inches by 17 inches.
3. Complete drawings and schematics of proposed control system, including panel power requirements.

B. Quality Control Submittals:

1. Manufacturers' Certificates of Conformance.
2. Operation and maintenance manuals.
3. Manufacturer's Certificate of Proper Installation.
4. Detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt the arrangement or details shown to the equipment and materials furnished.
5. Programmer's manual.
6. Record of system adjustments.

C. Contract Closeout Submittals:

1. Record Documents:
   a. Approved Shop Drawings.
   b. Complete as-built wiring diagrams.
   c. Recommended Spare Parts List:
      1) Quantities and replacement frequency.
      2) Current list prices, valid for 90 days after system acceptance.
      3) Availability and nearest distributor.

1.6 QUALITY ASSURANCE

A. Qualifications of System Designer:

1. Capable of furnishing factory trained technicians, competent to provide instruction, routine maintenance, and emergency service, on the site within 48 hours upon receipt of request.
2. Experienced in design and manufacture of computerized automated building control and energy management systems similar in performance to that specified.

1.7 MAINTENANCE

A. Maintenance Service: Furnish a draft maintenance agreement prepared and signed by the manufacturer to provide the necessary preventive maintenance to keep the various control systems in proper working condition. Fully describe the maintenance work to be performed, and estimate cost of the maintenance, during the 1-year correction period and the subsequent year.

B. Extra Materials: Furnish, tag, and box for shipment and storage the following special tools:

Item	Quantity
Portable Service Tools for Zone and Local Controllers	Two complete

PART 2 PRODUCTS

2.1 ENERGY MANAGEMENT AND CONTROL SYSTEMS (EMCS)

A. Manufacturer: Invensys Environmental Controls.

B. No “or equal” or substitute products will be considered.

2.2 BUILDING AUTOMATION SYSTEM (BAS) COMMUNICATIONS

A. Network Interface Modules (NIMs): The BAS Contractor shall provide a high speed Network Interface Module (NIM) that shall plug directly into the GCM which supports one of the following types of communication standards between GCMs:

1. Ethernet:
   a. The BAS-LAN shall employ Carrier Sense Multiple Access/Collision Detect (CSMA/CD) contention type protocol, which adheres to the industry standard format IEEE 802.3. The content of messages shall be the manufacturer's standard. The BAS-LAN components shall be manufacturer's standard or available from third party vendors, which utilize the same chip implementation as used by the manufacturer. In addition Ethernet NIMs shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3 compliant Ethernet Networks.
   b. Ethernet NIMs shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity:
      1) 10Base2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors).
      2) 10BaseT (Twisted-Pair RJ-45 terminated UTP cabling).

2. Echelon:
   a. The BAS-LAN shall employ LonTalk communications utilizing the LonWorks Neuron chip that conforms to the International Standards Organization's (ISO) seven layer Open Systems Interconnect (OSI) network protocol model. The content of messages shall be the manufacturer's standard. The BAS-LAN components shall be manufacturer's standard or available from third party vendors that utilize the same chip implementation as used by the manufacturer.
   b. The Neuron chip and a transformer-isolated transceiver shall provide for 1.25 Mbps communications over Category 4 Unshielded Twisted Pair (UTP) cabling.
3. System Expansion: To facilitate large single facility expansion or to support large Wide Area Networks (WANs) such as employed in large school systems, the Network Interface Modules (NIMs) shall directly support a minimum of 4 logical networks using the same physical network (Ethernet or Echelon). Each logical network shall support up to 30 GCMs.
4. Fiber Optic Communications:
   a. The temperature control Contractor shall provide a dual channel fiber optic data link, as shown on the Drawings and plans, to minimize the effects of transient surges caused by lightning or external EMI generating equipment. The data link shall be comprised of a single duplex cable containing two fibers (transmit and receive), of 62.5 micron construction, to accommodate data rates of 10 Mbps for Ethernet or 1.25 Mbps for Echelon.
   b. The fiber optic trunk shall be connected to GCM devices using manufacturer's standard Echelon wire to fiber optic repeaters or off the shelf Ethernet repeaters. Repeating devices shall contain separate LED indication for each communication interface to indicate proper operation of all aspects of the device. Fiber repeating devices shall be tested and conform to transient surge withstand tests for electrical devices, ANSI C62.41 IEEE 587 Categories A and B. Manufacturer's data sheet shall provide evidence of compliance with this requirement. Manufacturer's products, which do not meet this minimum performance requirement, shall not be acceptable.

B. Controller Trunk Communications:

1. The distributed communication network system shall consist of a multi-drop RS-485 bus architecture connecting LCMs, AHDCs, LIDCs, GDCs, UDCs and VAVDCs. The trunk shall consist of:
   a. A twisted pair of wires (24 AWG) completely encased in continuous metallic conduit.

b. Or a twisted shielded pair of wires (24 AWG) with the shield grounded in accordance with the manufacturer's wiring practices.
c. Or a dual channel, 62.5 micron fiber cabling system with ST-type connectors.

2. There shall be no power wiring, in excess of 30V ac rms voltage, run in conduit with communications trunk wiring. In cases where power or signal wiring is run in conduit with trunk wiring, all communications trunk wiring and power wiring shall be run using separate twisted shielded pairs (24 AWG) with the shields grounded in accordance with the manufacturer's wiring practices.
3. RS-485 Communication Transient Protection:
   a. The manufacturer's catalog data sheet shall provide evidence that all BAS products offered by the manufacturer are tested and comply with the standard for Transient Surge withstand capabilities for electrical devices ANSI C62.41, IEEE 587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE 587 shall imply conformance with IEEE 472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards.
   b. In addition, at each building entry and exit point, the wire communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection specifications of the General semiconductor, Model #422E device. Transient surge protection is not necessary if the communication trunk, external to the building, is fiber optic in nature.
   c. The communications circuitry and input/output circuitry, of the GCMs, LCMs, AHDCs and VAVDCs, shall provide protection against a 1,000 volt, 3 amp transient signal, directly applied to the communication or input/output termination's. The manufacturer's catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the BAS controller. Protection shall be provided for the individual communications and input/output terminations for each BAS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.
4. RS-485 Trunk Distance and Topology:
   a. At data rates of up to 19.2 Kbaud, the trunk distance shall be extendible to distances of up to 20,000 feet using RS-485 communication wire or fiber optic repeaters. A repeater shall be used each 4,000 feet of linear distance for wire or every 6,500 feet for fiber optics. Repeating devices shall contain separate LED indication for each communication interface trunk to indicate proper operation of the repeater as well as the communications

trunks. Contractors shall provide devices that are of BAS control system manufacturer's design.

b. It shall be possible for the trunk to be "T"eed or "Star"ed, at any location using a repeater, to facilitate the installation. Systems that do not provide this capability shall provide a trunk riser diagram showing end to end distances and locations of system topology necessary to meet the trunk diagram shown on the plans.

2.3 STANDALONE DIGITAL CONTROLLERS (GCM)

A. General:

1. Standalone Digital Controllers (GCM) shall be 16-bit microcomputer based, utilizing a multi-tasking, multi-user operating system.
2. The GCM controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the CONTRACTOR or User. Modification of the on-board GCM controller database shall be performed on-line using the built-in or HHOT interface. Systems that require the GCM to be removed from service while DDC control sequences are modified shall not be acceptable.
3. GCM controllers shall utilize true floating-point arithmetic capabilities. To accommodate totalization of large totalized values, GCMs with reporting capability shall support the calculation, accumulation and display of values within the range of ±10 to the 10th power.

B. Database and Memory Backup: All programming defining the functions to be performed by the GCM, including but not limited to application programs and point database within each GCM, shall be protected from loss due to power failure for a minimum of 6 months. Systems providing non-volatile memory for these functions are preferred. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6 month period. Systems not in compliance shall provide for uninterrupted power to each GCM.

C. Service Ports:

1. GCM controllers shall be equipped with a minimum of two operator service ports for the connection of a HHOT. The service ports shall be either a built-in RS-232 data terminal port or a RJ-11 type jack that connects to the manufacturer's standard HHOT.
2. Connection of a service device, to a service port, shall not cause the GCM controller to lose communications with its peers or other networked device controllers.

3. The service port shall allow utilization of the same HHOT from any location. The same HHOT shall be utilized for any GCM, LCM, AHDC, UDC, LIDC or VAVDC. Systems that utilize more than one variety of HHOT shall not be acceptable.

D. Display and Readout Capability:

1. The GCM controller shall provide a built-in operator interface, which consists of an alphanumeric LCD display of 4 lines x 20 characters, and a multi-function keyboard. Devices without such built-in displays shall provide a permanently connected HHOT as described elsewhere in this specification.
2. The GCM controller shall additionally provide diagnostic LED indication of device transmit and receive data communications for all communication port and peripheral ports, normal operation, abnormal operation and control relay operation indication.

E. Manual/Auto Control and Notification:

1. The GCM controller shall provide commanded override capability from the HHOT or the built-in operator interface. Such overrides shall be annunciated to the CHSs. Such overrides shall be valid as long as power is applied to the controller.
2. Manual service overrides, such as Hand/Off/Auto switches, shall be provided as indicated on the Drawings. Such overrides shall be located at the controlled device location and conform to OSHA manual lockout regulations, as appropriate, for safety reasons. GCM indication of such manual override actions shall be provided as feedback status indication points shown on the Drawings, in conjunction with the application programs within the GCM. Systems which provide built-in H/O/A switching devices with integral feedback shall provide external manual service overrides, as indicated, to comply with OSHA manual lockout regulations. H/O/A switches remotely located at the GCM controller are not acceptable.

F. Adjustments: Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual GCM. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the GCM. From a single GCM user interface, any other GCM shall be accessible and full adjustment capabilities shall be provided.

2.4 MECHANICAL SYSTEM DIGITAL CONTROLLERS (LCMS)

A. General:

1. Controls shall be microprocessor based, Mechanical System Direct Digital Controllers (LCMs). LCMs shall be provided for air handling units, packaged rooftops, primary and secondary pumping loop systems and other applications as shown on the Drawings. LCMs shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the LCM. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates sensor signals. All input/output signal conversion shall be performed through a minimum of a 12 Bit A-to-D converter. All input/output points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input/output points must be available as universally definable at the OWNER's discretion. If input/output points are not fully universal in nature, unused points must be equal in quantity between Analog Input, Digital Input, Analog Output, Digital Output.
2. CONTRACTOR shall provide a minimum of one LCM controller per mechanical system.
3. The BAS Contractor shall provide and field install all LCMs specified under this section. Mechanical Equipment manufacturers desiring to provide LCM type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors which are specified to be provided by the BAS/Temperature Control Contractor.
4. All input/output signals shall be directly hardwired to the LCM. Trouble shooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be used.
5. LCM shall be in continuous direct communication with the network that forms the facility-wide Building Automation System (BAS). The LCMs shall communicate with the GCM at a baud rate of not less than 19,200 baud.

B. Non-Volatile Memory:

1. All control sequences programmed into the LCM shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall not cause the LCM memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The LCM shall allow

for the creation of unique application control strategies. Systems that allow selection of sequences from a library or table are not acceptable.

2. All control sequences shall be fully field programmable at the LCM controller, allowing for the creation or editing of an application sequence of operations.

C. Display and Readout Capabilities:

1. Each LCM shall be provided with a built-in Operator Interface that has a minimum of a 2 line by 20-character display. The built-in operator interface shall allow the operator to view up to twenty dynamic, scrolling values, without accessing the controller through the keypad. Upon controller reset the scrolling values shall automatically return without operator intervention.
2. The built-in display shall be mounted securely within the locked enclosure of the LCM, but the display and keypad shall be accessible at all times. The LCM shall be mounted such that the display is at eye level with the average operator (5 feet, 9 inches from the floor).
3. The built-in display shall allow access to all application program data and real time data within the LCM. All information and commands shall be fully prompted for the operator. Via the built-in operator interface, the operator shall be able to view the operation application program sequence. In addition, the built-in operator interface shall allow the operator to modify or create an application program, on-line, without disrupting the existing operation of the controller.

D. Spare Point Capacity: Digital controller based control panel bids shall include in every panel, additional capacity for future installation of desired equipment, at the OWNER's discretion. Provide expansion capacity of at least 20 percent for every panel. Any input/output cards or modules required to utilize the spare points shall be provided. Expansion capacity shall include equal quantities of every point type; Analog input, Digital input, Digital output, and Analog output. Systems providing modulating outputs via pulse width modulation techniques, shall provide within each panel all the components required to implement the functions equivalent to an analog output.

E. Sensing and Control Outputs Requirements:

1. Sensing:
   a. All sensing inputs shall be provided via industry standard signals. Temperatures, humidities, differential pressure signals, and other signal inputs shall be one of the following types:
      1) 0 to 20 mA.
      2) 4 to 20 mA.
      3) 0 to 5V dc.
      4) 0 to 12V dc.

5) 1,000-ohm platinum (at 0 degrees C, 2.62 ohms/C).
6) 1,000-ohm Balco (2.3 ohms/degree F).
7) 10k-ohm Thermistor (at 25 degrees C/77 degrees F).
8) Custom, definable input signals (accept sensor inputs from RTD devices, other than those of the manufacturer).

b. All signal inputs shall be compatible with the controllers used, and with the requirements for readout of variables in true scaled engineering units as specified.

2. Control Outputs:

a. On/Off Outputs: Control panel shall internally provide test points for the circuit driving the equipment contactor, for the purpose of troubleshooting the 120V ac or 240V ac circuit to the contactor. All such relays or digital output modules shall provide a pilot light or LED display of this same status. On/Off output modules shall be of the modular construction that can be easily and quickly replaced, on an individual basis, if the module were to be damaged.

b. Modulating Outputs:

1) Modulating outputs shall be industry standard 0 to 5V dc, or 0 to 12V dc with definable output spans, to adapt to industry available control products. Milliamp outputs of 0 to 20 mA or 4 to 20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable provided that they also comply with the following requirements.

2) All modulating outputs shall provide within the control panel, a meter gauge, or display indication via on board display or HHOT, the commanded position signal for the actuating device. This meter, gauge, or display must provide either a 0 to 100 percent position indication, or read out directly in the engineering units of the signal being used. Drive open/drive closed type controllers shall include sufficient components and control algorithms to comply with this requirement. In the case of Drive open/closed technology, position feedback shall be provided to insure positive indication that the control device is at the commanded position.

3) The above requirements for modulating outputs shall be complied with by all system bids.

F. Facility Management:

1. The LCM shall allow for internal processing and reporting of user defined Time of Day Schedules, Alarms, Trend Reports, Run Time Totalizations, Energy Utilization Reports, Application Program Documentation and interface with a peripheral device such as an

autodial/autoanswer modem, a VT-100 Display Terminal, or a serial printer.

2. Systems not providing the above functionality at the LCM are not acceptable and shall utilize a GCM in place of the LCM.

G. Diagnostics: The LCM shall provide LED indication of transmit/receive communications performance as well as for the proper/improper operation of the controller itself.

H. Battery: The LCM shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to 30 days without loss of setting. The battery for the time clock shall be field replaceable by the customer. Integral daily, weekly, holiday, and special event scheduling shall be provided, such that all schedules can be custom tailored to the facility. Predefined schedules, with set quantities of on/off cycles are not acceptable.

I. Controller Location:

1. To simplify controls, mechanical service and troubleshooting, the LCM shall be mounted directly in or on the control compartment of the mechanical system. The LCM shall be provided in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The LCM shall be constructed in a modular orientation such that service of the failed components can be performed quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of three. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. The LCM shall allow for the creation of, unique, application control strategies. Systems that allow selection of sequences from a library or table are not acceptable. This shall allow all controls maintenance and troubleshooting to be made while at the unit location. LCM shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.
2. For compatibility to the environment of the mechanical systems, LCM shall have wide ambient ratings. LCM shall be rated for service from -40 to 140 degrees F.
3. CONTRACTOR shall submit description of location for the LCMs on all mechanical equipment.

2.5 VARIABLE AIR VOLUME DIGITAL CONTROLS (VAVDCs)

A. General:

1. Controls shall be microprocessor based Pressure Independent or Variable Air Volume Digital Controllers (VAVDC). The VAVDC shall be based on a minimum 16-bit microprocessor working from software

program memory that is physically located in the VAV DDC controller. The VAV controller "intelligence" shall be resident within the same enclosure that translates sensor signals into digital information.

2. The VAVDC shall consist of a 16-bit microprocessor, power supply, enclosure, actuator (when required), differential pressure transducer, field terminations, field adjustments and operation/application system software in a single integrated package. Systems not providing a single integrated package shall provide documentation supporting the use of the individual components in the application. Documentation shall include life cycle information for the actuator, sensor and control accuracy verification for the combination of the products. All input/output signals shall be directly hardwired to the VAV DDC controller. Troubleshooting of input/output signals shall be easily executed through the HHOT connected at the wall sensor location.
3. The VAVDC controller shall have a room sensor with integral room setpoint adjustment. The room sensor/setpoint shall be capable of being hardwired shared by up to four VAVDCs, providing coordinated control of zones containing multiple VAVDCs. The sharing of the sensor/setpoint shall be through hardwire connection. Systems sharing room sensor data through communications shall not be acceptable. In cases where a single room sensor is to be shared by multiple controllers and the system cannot accommodate the functions; a wall sensor with multiple sensing elements and a ganged setpoint adjustment, under a single sensor, shall be employed. The room sensor shall contain a pushbutton for override of unoccupied conditions and a plug-in communications jack for connection of the HHOT.
4. VAVDCs shall be provided by the BAS Contractor, to the VAV box manufacturer, for factory mounting. The VAV terminal unit supplier shall include, in its price, all costs for mounting of VAVDC controller, connection of actuator to damper shaft, wiring of device power, wiring of VAVDC to fan (fan powered terminal) and wiring reheat valve actuator as specified on drawing.

B. VAVDCs shall be in continuous, direct communication with the network which forms the facility wide building automation system. The VAVDCs shall communicate with the GCM at a data baud rate of not less than 19,200 baud.

C. The VAVDC shall be provided with the ability to interface with the HHOT. The interface port shall be provided at the wall sensor or at the controller, as specified on the plans. The interface port shall allow the HHOT to have full functionality as described in Article HAND HELD OPERATOR TERMINALS (HHOT) of this specification. From the interface port, the HHOT shall be able to directly access any AHDC, LIDC, UDC or VAVDC in the network.

1. Through the palm-top HHOT, the VAVDC shall support a fully prompted Air Balance sequence. The palm top HHOT shall, when connected to the wall sensor, automatically access the connected VAVDC unit. Systems requiring an address number or an access code to be entered, shall not be acceptable. The air balance sequence shall step the balancing Contractor through the checkout and calibration of the VAVDC. Upon completion of the balancing sequence, the flow values presented by the VAVDC shall match those observed by the balancing Contractor's measurement equipment. Additionally, upon completion of the air balance, the GCM shall automatically archive the balance settings for future use if the controller were to require replacement. Systems not able to provide a formatted air balance HHOT, shall not be acceptable.
2. Through this specification requirement, the discrepancies between the readings at the VAVDC/GCM/CHS and the balancing Contractor's measurement devices, will be eliminated. As a minimum, the balancing program shall step the balancing Contractor through the following functions:
    a. Check damper linking for full end to end stroke travel.
    b. Verify and set maximum CFM flow valve.
    c. Calibrate Maximum CFM flow valve.
    d. Verify and set minimum CFM flow valve.
    e. Calibrate minimum CFM flow valve.
    f. Verify and set reheat flow setpoint.
    g. Calibrate reheat flow setpoint.
    h. Verify and set parallel fan start point.
    i. Calibrate parallel fan start point.

D. The VAVDC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.

E. The VAVDC shall be capable of supporting a VAVDC powered, direct plug-in communications repeater allowing for the "T"eeing or "Star"ing of the communications wiring. The plug-in communications repeater shall simplify the network topology by accommodating the various floor plan layouts of the facility.

Systems unable to provide a plug-in communications repeater shall employ standard communications repeaters, mounting these repeaters at the VAVDC where the wiring is to be "T"eed or "Star"ed. The repeaters shall provide quick disconnect terminations for the communications and power wiring, allowing easy troubleshooting and replacement. If the repeater is to be powered from the same source as the VAVDC, the power transformer shall be adequately sized.

F. The VAVDC control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components of the VAVDC. The VAVDC shall provide zone control accuracy of not more than ± 1 degree F. Systems providing control accuracy's greater than ± 1 degree F shall not be acceptable. With the submittal package, CONTRACTOR shall provide performance data that verifies control accuracy of the VAVDC.

The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The VAV terminal unit manufacturer shall supply a line to low voltage transformer, of sufficient capacity, to power the VAVDC plus all reheat valves and/or contactors and fan circuits associated with the VAV terminal and actuator assemblies. The BAS Contractor shall provide all reheat control valves to the mechanical Contractor for mounting and piping. The BAS Contractor shall provide and install all wiring between the valve and VAVDC controller and between the room sensor and the VAVDC controller.

G. Non-Volatile Memory: All control sequences programmed in the VAV controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall, therefore, not cause the VAV controller memory to be lost, nor shall there be any need for batteries to be recharged or replaced. The VAVDC shall employ global positioning strategies and actuation response times, sufficient to allow compliance with NFPA-92.

H. Controller Location:

1. To simplify controls, mechanical service and troubleshooting, all components of the VAV controller shall be mounted directly at the Variable-Air-Volume terminal box. Enclosure assembly shall be mounted and positioned so that it is easily accessible to operational personnel.
2. The VAVDC shall be powered by a 24V ac power source and shall comply with Class 2 wiring requirements.
3. For compatibility to the environment of a VAV terminal box, the VAVDC controller shall have wide ambient ratings for specified controls sequences and performance. VAVDC shall be rated for service from 40 to 140 degrees F.
4. CONTRACTOR shall submit description of location of VAVDC controller on VAV terminal box.
5. For compatibility of use, in the supply or return air plenums, the VAVDC enclosure shall be constructed to comply with the requirements of UL-465.

I. Controller Point Capacity:

1. Cooling Only Units:
   a. The VAVDC controller shall provide input/output points as follows:
      1) Self-calibrating Velocity Pressure input (0 to 2 inches WC). The velocity pressure transducer shall be a continuously self-calibrating unit, which determines the zero velocity pressure point, by equalizing the pressure across the sensing element, every 10 to 15 seconds.
      2) Room Temperature Input.
      3) Occupancy Override Input.
      4) VAV Box Damper Output: Unless otherwise specified, the controller shall provide a minimum 30 pounds per inch integral electric actuator, having a 90-degree stroke rotation in a time of 3 minutes maximum.
      5) Occupancy or Status Input.
      6) 0 to 100 Percent Position Indication of Primary Damper Actuator -Direct feedback from damper actuator.
      7) Room Setpoint Input.
      8) Auxiliary Temperature Input.
      9) HHOT Interface.
2. Reheat Units:
   a. In addition to the inputs and output points described in Paragraph Cooling Only Units, VAVDC controllers which are reheat configurations shall provide the following additional control points:
      1) A minimum of four, Form A, digital outputs for floating valve actuator control or occupancy control of blinds, lights, etc. Contact outputs shall be capable of accommodating 120V ac pilot duty loads. Systems unable to accommodate the 120V ac requirement shall provide interface relays for all controlled loads.
      2) A 4 to 20 mA (2 to 10V dc, 1 to 5V dc) proportional analog output signal for control of a proportioning hydronic reheat valve.
3. VAV Terminals with Actuator by VAV Terminal Manufacturer:
   a. In place of the internal actuator specified in Subparagraph 4) of Paragraph Cooling Only Units, and in addition to the inputs and outputs specified in Paragraph Reheat Units, the VAVDC controller shall provide one of the two outputs below:
      1) Two additional, solid state electronic triacs to drive VAV terminal manufacturers 24 volt, synchronous, floating motor actuators.

2) A 4 to 20 mA dc output or 3 to 15 psi pneumatic output for interface to VAV terminals with analog or pneumatic actuators.

b. For externally actuated controllers, the controller shall provide the commanded output position as a feedback signal.

2.6 HAND HELD OPERATOR TERMINALS (HHOT)

A. The HHOT shall be provided in quantity of (1). As a minimum, provide a portable laptop computer the following:

1. Intel Pentium III 600 microprocessor.
2. 128 Megabytes RAM.
3. 6.4 Gigabyte hard drive.
4. 3-1/2-inch 1.44 meg disk drive.
5. Parallel port and serial port and appropriate interface devices to allow connection to any controller within the network.

B. The computer shall contain a full ASCII alphanumeric keypad and rechargeable battery package. The computer shall operate for a minimum of 2 hours without recharging or connection to line voltage power.

C. The HHOT software shall allow the operator to directly connect to any controller within the facility EMCS. When connected, the HHOT shall allow viewing, editing and programming capabilities for the connected controller or any other controller within the network. The HHOT shall graphically display real time point data or graph trended data within the AHDC, UDC, LIDC or VAVDC controllers. The HHOT shall allow off line database creation or editing, along with database upload and download utilities, allowing controller databases to be archived on the permanent disk or floppy diskettes. Systems not capable of providing the above capabilities shall provide their CHS software on a notebook equivalent hardware platform, as defined for the CHS, in the quantities defined for the HHOT.

D. The HHOT shall be provided with the manufacturer's standard HHOT software. The same device shall accomplish the interface and programming capabilities for all controllers within the facility EMCS. Systems that require multiple devices for interfacing or programming shall not be acceptable.

2.7 SYSTEM SOFTWARE DESCRIPTION

A. General:

1. CONTRACTOR shall provide all software for a complete and operational system as described herein. Software shall include manufacturer's standard multi-tasking, multi-user operating system for operator consoles and controllers, network communication software for

dial-up and hard trunk applications, operator man-machine interface software, control application software and all other software necessary to provide the functions specified herein.

2. System software shall be as manufactured by Siebe Environmental Controls. Software products by other controls manufacturers shall be considered equal if all performance criteria of these specifications are met.

B. Local Area Network Software and Operations:

1. Network Shared Data: The BAS system local area networks shall provide for the sharing of calculated and control point variable values throughout the BAS network. The CONTRACTOR shall provide all network software links as necessary to provide a complete and functioning system in accordance with the sequences of operation.
2. Network Diagnostics:
   a. The CHS and CCS systems shall provide software utilities to determine the on-line status of all network connected controllers (GCM, LCM, AHDC, UDC, VAVDC, LIDC).
   b. If network connected controller drops off-line, the network software shall detect and annunciate such conditions to the proper output devices.
3. Network Performance:
   a. The BAS communication networks shall provide end-to-end data transmission of all necessary control point values at a minimum rate of that established by standard NFPA-90A for smoke control operation.
   b. The nominal network response speed for a data request entered at a man-machine interface for data contained in another panel shall not be greater than 30 seconds.
   c. The nominal network response time for an alarm reporting shall not exceed 10 seconds. Ten seconds is the time from when the alarm is initiated to when the CHS receives the message. This specification applies to all GCMs and LCMs. For AHDC, LIDC, UDC and VAVDC initiated alarms, response times shall not exceed 30 seconds, based on the previously described conditions.

C. Stand-Alone Digital Controller (GCM) Software:

1. Operating System:
   a. GCM operating system software shall be multi-tasking. The multi-tasking capability of the GCM shall provide the capability to simultaneously perform at least, but not limited to, the following functions:

1) Downloading of application program changes to the GCM without affecting the simultaneous operation of existing operating application programming.
2) Printing of scheduled or on-demand reports without preempting operator functions.

2. Standard Software Function Libraries:
   a. All GCMs shall have as a standard feature of their system software, complete libraries of control algorithms for DDC, Energy Management, and Facilities Management functions. These resident libraries of algorithms shall be dawn from for the creation of the application programming of each individual GCM.
   b. Controllers that provide custom application software via line-by-line programs shall not be acceptable unless all source and compiled program code is contained in totally non-volatile, but programmable EEPROM memory. Vendors providing line-by-line programmed controllers shall also provide program editors, compilers and de-bugging tools in each GCM panel's EPROM firmware to facilitate the on-line modification of application control sequences.
   c. The CONTRACTOR shall utilize these libraries to satisfy the sequences of operation specified. Systems which create these programs utilizing line-by-line programming methods and languages such as PASCAL, BASIC, "C" or similar, shall provide the OWNER with fully annotated source code of all application software modules used, and a 10-year escrow of such source code in a third party location, escrow to be paid up at time of bid.
   d. Each GCM shall be provided with PID control loops that incorporate a self-learning capability to eliminate all setup requirements for the Integral and Derivative of the control loop. Each control loop shall be individually tuned. Systems that do not provide automatically tuning loops are not acceptable.
3. Control Panel BAS Functions:
   a. It is the intent of this specification to provide the OWNER with the ability to read out temperatures and other values, and to adjust specific items from localized, as well as centralized locations. In order to provide this capability, control panels are specified to be placed in specific locations with readout gauges and adjustments to be mounted directly in the control panel.
   b. Every control panel shall provide readouts for the temperatures, or other information specified. Every control panel shall provide adjustments for the setpoints, parameters, and other adjustment functions specified.

4. Readout of Items:
   a. Items specified for readout shall be displayed on the face of the panel with either a digital display or analog electronic meter. The CONTRACTOR shall provide a minimum of 20 values per GCM panel with displays as indicated in the locations shown on the Drawings. Readout of sensed variables used in control sequences shall be from the same sensors used for control. As an alternative, provide either a duplicate sensor for the read out, or provide a transducer for each sensed signal that can provide both a readout signal and a signal compatible with the controller.
   b. Each readout item shall be individually named and labeled. Name label shall be directly adjacent to the actual display value of that item including the applicable engineering units. Label shall be a part of the digital display of that value, or a Bakelite label mounted directly above the value display. Display readout requirements are in addition to capabilities provided by plug-in operator devices which are provided as part of digital controller-based systems.
5. Adjustments:
   a. Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be made at each control panel. The preferred method for adjustments is a dedicated adjustment pad, or individual adjustment potentiometers providing direct input to the affected loop controller or sequence controller.
   b. For systems where the OWNER is providing a HHOT, the same HHOT unit shall be used at all controller and wall sensor locations throughout the BAS network. Systems that provide more than one type of HHOT shall not be acceptable.
6. Alarm Dial Out:
   a. The GCM system shall provide built-in software with the capability to automatically dial out an alarm to up to 10 remote reporting locations. The remote reporting location shall be any one of the following, which are connected to a phone modem.
      1) A CHS or multiple CHS computer workstations.
      2) A CCS CRT printer, or multiple CCS CRT printer locations.
      3) An ASCII printer.
   b. Based on time of day or event initiated programs, the GCM software shall permit an alarm to select any one of three dial-up tables. Each table shall consist of a subset of the 10 phone numbers. The alarm shall cause the selected table to dial out and report the alarm to all phone numbers listed in the table selected.

c. Reporting of an alarm to only a single phone number in the table shall not be acceptable as it negates the need to notify the OWNER and a service Contractor and the person on call, if necessary.

7. Exception Reporting Sequences:
   a. Alarm/COS Reports:
      1) For those analog points indicated on the Drawings, the CONTRACTOR shall provide a unique high/low limit alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.
      2) For those digital points indicated on the Drawings, the CONTRACTOR shall provide a unique change-of-state alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.
      3) For those points indicated on the Drawings which are designated as interrupt priority, the CONTRACTOR shall provide an interrupting process display at the CHS location which displays the current conditions for the operator.
      4) For those points designated in the paragraph above, the BAS shall also send a history log to the system report printer of the immediate prior history of the points causing the interrupt priority. This log shall contain 1-minute samples of the previous 15 minutes of operation.
   b. Off-Hours Exception Reporting: The OWNER shall specify up to five sites to which off-hours exceptions shall be auto-dialed and reported. This shall allow the OWNER to assign off-hours exception responses to various facility personnel as necessary. Selection of the site to be dialed can be programmed by the OWNER, and set to change automatically per time of day and day of week.

D. Mechanical System Digital Controller (LCM) Software:

1. Operating System:
   a. LCM operating system software shall be multi-tasking. The multi-tasking capability of the LCM shall provide the capability to simultaneously perform at least, but not limited to, the following functions:
      1) Downloading of application program changes to the LCM without affecting the simultaneous operation of existing operating application programming.
      2) Printing of scheduled or on-demand reports without preempting operator functions.

2. Standard Software Function Libraries:
   a. All LCMs shall have as a standard feature of their system software, complete libraries of control algorithms for DDC, Energy Management, and Facilities Management functions. These resident libraries of algorithms shall be drawn from for the creation of the application programming of each individual LCM.
   b. Controllers that provide custom application software via line-by-line programs shall not be acceptable unless all source and compiled program code is contained in totally non-volatile, but programmable EEPROM memory. Vendors providing line-by-line programmed controllers shall also provide program editors, compilers and de-bugging tools in each LCM panel's EPROM firmware to facilitate the on-line modification of application control sequences.
   c. The CONTRACTOR shall utilize these libraries to satisfy the sequences of operation specified. Systems which create these programs utilizing line-by-line programming methods and languages such as PASCAL, BASIC, "C" or similar, shall provide the OWNER with fully annotated source code of all application software modules used, and a 10-year escrow of such source code in a third party location, escrow to be paid up at time of bid.
   d. Each LCM shall be provided with PID control loops that incorporate a self-learning capability to eliminate all setup requirements for the Integral and Derivative of the control loop. Each control loop shall be individually tuned. Systems that do not provide automatically tuning loops are not acceptable.
3. Control Panel BAS Functions:
   a. It is the intent of this specification to provide the OWNER with the ability to read out temperatures and other values, and to adjust specific items from localized, as well as centralized locations. In order to provide this capability, control panels are specified to be placed in specific locations with readout gauges and adjustments to be mounted directly in the control panel.
   b. Every control panel shall provide readouts for the temperatures, or other information, specified. Every control panel shall provide adjustments for the setpoints, parameters, and other adjustment functions specified.
4. Readout of Items:
   a. Items specified for read out shall be display on the face of the panel with either a digital display or analog electronic meter. The CONTRACTOR shall provide a minimum of 20 values per LCM panel with displays as indicated in the locations shown on the Drawings. Read out of sensed variables used in control sequences shall be from the same sensors used for control. As an alternative, provide either a duplicate sensor for the read out, or provide a

transducer for each sensed signal which can provide both a read out signal and a signal compatible with the controller.

b. Each read out item shall be individually named and labeled. Name label shall be directly adjacent to the actual display value of that item including the applicable engineering units. Label shall be a part of the digital display of that value, or a Bakelite label mounted directly above the value display. Display readout requirements are in addition to capabilities provided by plug-in operator devices which are provided as part of digital controller-based systems.

5. Adjustments:
   a. Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be made at each control panel. The preferred method for adjustments is a dedicated adjustment pad, or individual adjustment potentiometers providing direct input to the affected loop controller or sequence controller.
   b. For systems where the OWNER is providing a HHOT, the same HHOT unit shall be used at all controller and wall sensor locations throughout the BAS network. Systems which provide more than one type of HHOT shall not be acceptable.
6. Alarm Dial Out:
   a. The LCM system shall provide built-in software with the capability to automatically dial out an alarm to up to 10 remote reporting locations. The remote reporting location shall be any one of the following which are connected to a phone modem:
      1) A CHS or multiple CHS computer workstations.
      2) A CCS CRT printer, or multiple CCS CRT printer locations.
      3) An ASCII printer.
   b. Based on time of day or event initiated programs, the LCM software shall permit an alarm to select any one of three dial-up tables. Each table shall consist of a subset of the 10 phone numbers. The alarm shall cause the selected table to dial out and report the alarm to all phone numbers listed in the table selected.
   c. Reporting of an alarm to only a single phone number in the table shall not be acceptable as it negates the need to notify the OWNER and a service Contractor and the person on call, if necessary.
7. Exception Reporting Sequences:
   a. Alarm/COS Reports:
      1) For those analog points indicated on the Drawings, the CONTRACTOR shall provide a unique high/low limit

alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.

2) For those digital points indicated on the Drawings, the CONTRACTOR shall provide a unique change-of-state alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.

3) For those points indicated on the Drawings that are designated as interrupt priority, the CONTRACTOR shall provide an interrupting process display at the CHS location which displays the current conditions for the operator.

4) For those points designated in the paragraph above, the BAS shall also send a history log to the system report printer of the immediate prior history of the points causing the interrupt priority. This log shall contain 1-minute samples of the previous 15 minutes of operation.

b. Off-Hours Exception Reporting: The OWNER shall specify up to five sites to which off-hours exceptions shall be auto-dialed and reported. This shall allow the OWNER to assign off-hours exception responses to various facility personnel as necessary. Selection of the site to be dialed can be programmed by the OWNER, and set to change automatically per time of day and day of week.

2.8 SENSORS

A. Linear precision resistance rigid elements, resistance averaging elements and resistance space temperature elements as indicated on the control diagrams, and on the I/O point summary for temperature sensing:

1. Room Temperature:
   a. Accuracy: ± 1 degree F.
   b. Range: 30 to 100 degrees F.
   c. Cover:
      1) Without thermometer.
      2) With adjustable setpoint, except as noted.
      3) With override button, except as noted.
      4) With service tool jack.
   d. Mount 60 inches above finish floor, except as noted.
2. Duct Temperature:
   a. Accuracy: ± 1 degree F.
   b. Range:
      1) Heating: 40 to 140 degrees F.
      2) Cooling: 25 to 100 degrees F.
   c. Element:
      1) Rigid insertion, 12-inch length, through sealed opening in center of duct.

2) Averaging, for ducts or plenums with any dimension greater than 36 inches. Sealed opening in duct. Element supported through center of duct to prevent vibration.

d. Cover: NEMA 250, Type 1.

3. Water Temperature:
   a. Accuracy: ± 1 degree F.
   b. Range: Heating, 100 to 240 degrees F.
   c. Element: Removable insertion into pipe thermowell.
   d. Cover: NEMA 250, Type 1; in accordance with NFPA 70.
4. Outdoor Temperature:
   a. Accuracy: ± 1 degree F.
   b. Range: -40 to 140 degrees F.
   c. Cover: Weathertight, with sealed conduit connection.
5. Pressure, General:
   a. Accuracy: 1 percent of range.
   b. Range: 150 percent of measured variable.
   c. Mount nonvibrating.
   d. Cover: NEMA 250, Type 1.
6. Duct Air Static Differential Pressure:
   a. MAMAC, transmitter.
   b. Dwyer A302, duct probe.
   c. Outdoor atmospheric pressure reference tubing connection.
7. Space Air Static Differential Pressure:
   a. MAMAC, transmitter.
   b. Outdoor atmospheric pressure reference tubing connection.
8. Water Pressure:
   a. Dwyer No. 630 Series, 0 to 20 psi range.
   b. Robinson Halpern No. 151 Series.
9. Water Differential Pressure:
   a. Dwyer No. 630 Series, 0 to 20 psi range.
   b. Rosemount No. 1151-DP Series.
   c. Include three-valve manifold connection.
10. Position, 0 to 100 percent open, for damper, inlet vane, or similar: Potentiometer, 0 to 2000 ohm equals 0 to 100 percent.
11. Humidity Sensors:
   a. Accuracy: ± 1 percent of indicated value.
   b. Range: 10 to 95 percent.
   c. Solid state.

B. RTD to voltage (0- to 5-volt) converters with zero and span adjustments for use with the MUX analog inputs.

C. Limited range thermistors are acceptable provided they sense the range expected for the point at the specified accuracy with a 0 to 5V output.

D. Sense filter pressure drop for each filter bank specified on the point list by means of a differential pressure sensing device which closes an electrical contact when the filter pressure differential exceeds an adjustable pressure range setting.

E. Differential pressure sensing devices for each fan specified in the point list.

F. Auxiliary contacts for each fan specified in the point list.

G. Indicate waterflow for each pump by means of a differential pressure switch or flow switch.

H. Auxiliary contacts for pumps.

I. START/STOP relay module for either momentary or maintained switch action as appropriate for the motor starter.

J. Pilot Relays:

1. Plug-in type.
2. Interchangeable.
3. Mounted on a circuit board.
4. Wired to numbered terminal strips.

K. Proper mode control at the relay panels to interface with the starter H-O-A switches located in the motor control centers or furnished separately.

2.9 DEVICES, BINARY MONITORING

A. Used for Status and Alarm Signals:

1. Run/stop.
2. On/off.
3. Open/close.
4. Normal high or low temperature.
5. Normal high or low humidity.
6. Normal high or low pressure.
7. Normal high or low flow.
8. Normal high or low level.
9. Normal fail.
10. Pulse rate accumulation, kWH meter.

B. Dry contacts, maintained, for 35V dc or less at 0.5 amps or less.

C. Temperature:

1. Room thermostat.
2. Duct thermostat, rigid element.
3. Duct thermostat, average element.
4. Pipewell thermostat.

D. Pressure, switch.

E. Air static, differential pressure switch.

F. Airflow, differential pressure switch.

G. Waterflow, differential pressure switch.

H. Damper position, end switch.

I. Motor status, current sensitive relay.

J. Fire alarm signal.

K. Motor starter auxiliary contact or relay.

2.10 EMCS OUTPUT FIELD DEVICES

A. Devices, Analog Output:

1. General:
   a. Proportional modulation positioning.
   b. Proportional capacity regulation.
   c. Proportional reset of setpoint.
   d. Use low voltage signals. 0 to 20 mA, 0 to 20V dc, 0 to 10V dc, or 0 to 5V dc.
2. Actuator for dampers and inlet vanes.
3. Actuator for valves.
4. Transducer for SCR heat control.
5. Transducer for positioning.
6. Transducer for setpoint reset.
7. Transducer for inverter drive speed reset.

B. Devices, Binary Output:

1. General, Two-Position Applications, Maintained or Momentary Contact:
   a. Start/stop.
   b. On/off.
   c. Open/close.

d. Use Low Voltage Signals:
   1) 30V dc or less.
   2) 30V ac or less.

2. Relay:
   a. Holding coil for low voltage.
   b. Contact rating for 10 amps at 240V ac.
   c. Enclosure, NEMA 250, Type 1.
3. Actuator, for dampers or valves, with three-point floating control, SPDT contact, for infinite position modulation.

2.11 DIFFERENTIAL PRESSURE SWITCHES

A. Manufacturers and Products:

1. SOR, Inc.; Model 17R3-K3.
2. Dwyer, Inc.; Series 1900.

2.12 LOCAL CONTROL PANELS

A. Furnish electric relays and coordinate with the supplier of magnetic starters for the auxiliary contact requirements.

B. Electrical Control Devices: Type to meet current, voltage, and switching requirement of the particular application.

C. Relays: Furnished with 24V ac coils and contacts rated at 10 amps minimum.

2.13 WATER FLOW SWITCHES

A. Water flow switches shall be McDonnell Model FS4-3 with single pole, double throw snap acting switch. Bearing shall be stainless steel and all parts inside the electric enclosure shall be zinc chromate plated. Point of switch shall be screw adjustable. Three-in-one paddle shall be suitable for all pipe sizes.

2.14 WATER FLOW METERS

A. Water flow meter shall be EMCO Model TMP (Turbo-Bar). The meter shall be insertion-type turbine flowmeter.

1. Ambient Temperature Limit: -20 to 140 degrees F.
2. Ambient Humidity Limit: 0 to 100 percent.
3. Relative Humidity, Linearity: $\pm$1.0 percent.
4. Repeatability: 0.25 percent.
5. The meter shall be compatible with EMCS.

2.15 MISCELLANEOUS ACCESSORIES

A. Relays, switches, transducers, and other field interface devices, for equipment located within the mechanical equipment rooms, shall be panel mounted.

B. Furnish a convenience 120V ac receptacle in each panel.

C. Wire electrical devices within the panel to a numbered terminal strip.

D. Run wiring within the panel in wiring tray in accordance with NEMA and UL standards, meeting all local codes.

E. NEMA type panels, suitable for applications as required.

F. Furnish a final as-built control diagram, reduced, laminated, and mounted inside panel door.

G. Smoke Detectors: Dual chamber ionization type to sense particles of combustion. As specified in Section 15950, HVAC CONTROLS.

H. Low-Limit Thermostats:

1. Line voltage type used to detect low temperature conditions in an airstream that could cause freeze-up conditions in water coils.
2. Liquid-filled type controller responsive only to the lowest temperature sensed along any 1-foot length of its 20-foot measuring element.
3. Adjustable controller.
4. Manual reset type controller.
5. Furnish line voltage to 24V ac transformer control voltage to the control system.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide the necessary installation, supervision, database installation, and field commissioning for a fully operational system.

B. Run control and interlock wiring in conduit sized to suit the number, type, and size of conductors as specified in Section 16120, CONDUCTORS. Install control and interlock wiring in conduit separate from power wiring.

C. Provide complete electric wire, cable, fittings, and conduit associated with the systems specified in this section, in accordance with the requirements of NFPA 70, National Electrical Code (NEC).

D. The installation and supervision of this project shall be carried out by factory trained personnel who are employed by the CONTRACTOR and licensed for this type of work.

3.2 APPLICATION SOFTWARE DOCUMENTATION

A. CONTRACTOR shall provide an AutoCad blueprint documentation of the software application program for each GCM, LCM, AHDC, UDC, VAVDC, and LIDC. Documentation provided shall include block software flowcharts, showing the interconnection between each of the control algorithms and sequences of operation. For systems utilizing program listings, a program listing shall be printed onto the same blueprint, along with the program flowchart, and description of the sequence of operation. This blueprint shall be stored and maintained in each GCM panel. System acceptance shall not be completed until this documentation is provided and located in each panel.

3.3 ACCEPTANCE TESTING

A. Point Verification: To verify end-to-end operation of the system, the CONTRACTOR shall provide a hard copy of an All Points Summary Listing to the COTR/CM of each part or system to be placed in warranty by the GOVERNMENT. For CHS systems, the CONTRACTOR shall additionally provide a print screen of the process display showing real time dynamic point information for all points on the subsystem(s) to be accepted.

B. Sequence Verification: The CONTRACTOR shall notify the COTR/CM of systems which perform all specified sequences. The COTR/CM shall verify all sequences of operation and place the system into warranty acceptance test.

C. Final Inspection: During final inspection, demonstrate to the satisfaction of the COTR/CM, the full operation of the complete system.

D. Operation and Maintenance Instruction:

1. Provide 2 days (8 hours per day) of onsite instruction of GOVERNMENT'S designated operating and service personnel by an authorized representative of the manufacturer.
2. Prepare an outline of the instruction and receive approval prior to scheduling the instruction.
3. GOVERNMENT will acknowledge completion of instruction in writing, which shall be a condition for request for final payment.

3.4 MANUFACTURERS' SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01640, MANUFACTURERS' SERVICES, for installation assistance,

inspection and certification of proper installation, equipment testing, startup assistance, and training of GOVERNMENT's personnel for specified system.

3.5 CLEANING AND PROTECTION

A. Keep system components and enclosures clean and free of dirt and debris until Substantial Completion.

B. Protect equipment and system components so as to turn over, at Substantial Completion, a system in "as new" condition. Repair or replace components damaged during construction with new components.

END OF SECTION

SECTION 15990
HVAC SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Associated Air Balance Council.
2. Air Moving and Conditioning Association, Inc. (AMCA): 203, "Field Performance Measurements of Fan Systems.
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. HVAC Testing, Adjusting, and Balancing Manual.
   b. HVAC Air Duct Leakage Test Manual.

1.2 SUBMITTALS

A. Quality Control Submittals:

1. Qualifications and experience record of air balancing and test agency.
2. Written verification of calibration of testing and balancing equipment.
3. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.3 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.
3. Certified by a national balancing association.
4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing and inspecting HVAC equipment and systems.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

1. Calibrate test instruments to a recognized standard before beginning the Work.

2. Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the Associated Air Balance Council or SMACNA "HVAC Testing, Adjusting, and Balancing Manual."

3.2 ADJUSTING AND BALANCING AIR SIDE

A. Measure fan system performance in accordance with AMCA 203.

B. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus 10/minus 0 percent.

C. In each system at least one airpath from fan to final branch duct termination shall have all dampers fully open. Achieve final air quantities by adjusting fan speed.

D. Adjust Fan Air Volumes:

1. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10/minus 0 percent.
2. After final adjustments, do not operate motor above nameplate amperage on any phase.
3. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
4. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Provide written notice to the air handling unit manufacturer and COTR/CM if drive or belt changes were made.

E. Adjust outside air dampers, return air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.

F. Read and record static pressures at unit inlet and discharge, filters, coils, dampers, plenums, and adjustable-volume boxes, on every supply, return, and exhaust fan.

G. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.

3.3 ADJUSTING AND BALANCING WATER SIDE

A. Adjust water systems for the required waterflows at each coil, connection, and terminal device.

B. Provide proper flow through individual circuits, each boiler loop, each pump, and all recirculation loops.

C. Measure and adjust flow through all valves and valve bypass lines, and mark final position of all balancing cocks, valves, and operators with a centerpunch.

3.4 FIELD QUALITY CONTROL

A. Vibration Testing:

1. Upon completion of the air and water system balance, perform vibration testing as specified below for the following rotating or reciprocating equipment.
   a. AHU-1
2. Vibration Test Procedures:
   a. Take measurements at every bearing housing using an IRD or General Radio calibrated electronic analyzer.
   b. Record log shall include equipment symbol, location, identification, and peak-to-peak displacement in a direction parallel to the shaft in a horizontal plane, and in a direction perpendicular to the shaft in both horizontal and vertical planes.
   c. Vibration Peak-to-Peak Amplitude Upper Limits:

Rotational Speed (rpm)	**Vibration Amplitude (mils)**
250	3.5
500	2.0
750	1.5
1,000	1.0
1,500	0.75

   d. If vibration peak-to-peak amplitude exceeds upper limits as specified, field balance equipment.

B. Balancing Log Report Requirements:

1. Log and record information from every test, reading, and adjustment necessary to accomplish the services described. In addition, record the following data:
   a. Equipment identification number.
   b. Equipment nameplate data (including manufacturer, model, size, type, and serial number).

c. Motor data (frame, hp, volts, FLA and rpm).
d. Sheave and belt size.
e. Starter and heater data.

2. Include a reduced set of HVAC Drawings in the balance log showing the final air and waterflow readings for each system.
3. Indicate the recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
4. Include a separate section in the log, if necessary, that describes operating difficulties in the air or water systems that could not be eliminated by the specified procedures. Identify these problems by system and location within the building, include an outline of a summary of the condition and its effect on the building, and describe corrective actions attempted.
5. After readjustment for vibration, measure and record the displacement only of the readjusted equipment to determine its conformance with the design.

C. Quality Control Verification: After adjustments have been completed and the balance logs submitted, the balancing and testing agency shall be available to demonstrate the air and water balancing procedures and vibration tests, and verify the test results.

1. Perform spot tests on a maximum of 20 percent of the total diffusers and grilles, on two air handling fan devices per building, and on 20 percent of the total water balance fittings, with measuring equipment used in the original tests, at random points selected by COTR/CM.
2. Results of these spot tests shall agree with the balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of the system as requested by COTR/CM.
3. At completion of the rebalance procedures, perform another spot test if required to verify those results.

END OF SECTION

SECTION 15992
PIPING LEAKAGE TESTING

PART 1 GENERAL

1.1 SUBMITTALS

A. Quality Control Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Notify COTR/CM in writing 5 days in advance of testing. Perform testing in presence of ENGINEER.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
3. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to COTR/CM.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to COTR/CM.

3.2 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

where:

L	=	Allowable leakage, in gallons per hour.
S	=	Length of pipe tested, in feet.
D	=	Nominal diameter of pipe, in inches.
P	=	Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.3 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.4 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2- gallon of water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered *defective* even if pipe previously passed a pressure test.

G. *Defective* Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.5 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge provided by CONTRACTOR at start of each testing day. COTR/CM will witness calibration.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered *defective* when time required for pressure to decrease from 3.5 to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed utilizing values from following table:

TABLE 1*

A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67

EXAMPLE: 15-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50

*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered *defective* even if pipe previously passed a pressure test.

E. *Defective* Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.6 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by CONTRACTOR and COTR/CM to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.2 QUALITY ASSURANCE

A. All electrical work shall be in accordance with the following codes and agencies:

1. The National Electrical Code (NFPA 70).
2. The National Electrical Safety Code (ANSI C-2).
3. The Life Safety Code (NFPA 101).
4. The Uniform Building Code.
5. The BOCA Basic Building Code.
6. Occupation Safety and Health Administration (OSHA).
7. Municipal ordinances governing electrical work.

B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM).
2. Underwriters' Laboratories, Inc. (UL).
3. National Electrical Manufacturer Association (NEMA).
4. Insulated Cable Engineers Association (ICEA).
5. Institute of Electrical and Electronic Engineers (IEEE).
6. National Fire Protection Association (NFPA).
7. American National Standards Institute (ANSI).
8. Edison Electric Institute (EEI).

1.3 MECHANICAL SYSTEM INTERFACE

A. All control wiring for plumbing and heating, ventilating and air conditioning systems shall be installed under Division 15. Review Division 15 specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 16 and wiring furnished under Division 15.

B. Motor controllers (starters) shall be furnished and installed under Division 16, unless specified to be furnished as an integral component of the equipment. Provide the number and type of auxiliary contacts necessary to interlock the equipment and provide the specified control sequence.

C. Power wiring to all motors and motor controllers and between motors and controllers shall be provided in Division 16.

D. All electric heating equipment shall be provided and installed under Division 15, HEATING, VENTILATING AND AIR CONDITIONING. Power wiring to all electric heating equipment shall be provided under Division 16 of these specifications.

1.4 SUBMITTALS

A. Quality Control Submittals:

1. Voltage Balance Report.
2. Equipment Line Current Report.
3. Factory test certification and reports for all major electrical equipment.
4. Site test certification and reports as specified in other Division 16, ELECTRICAL, sections.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:

1. Provide manufacturers' standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 EXECUTION

3.1 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.2 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.3 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. C55.1, Standard for Shunt Power Capacitors.
   b. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.
   c. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
2. American Society for Testing and Materials (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   c. A570, Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.
3. Federal Specifications (FS):
   a. W-C-596, Connector, Receptacle, Electrical.
   b. W-S-896E, Switches, Toggle, Flush Mounted.
4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c. CP 1, Shunt Capacitors.
   d. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
   e. KS 1, Enclosed Switches.
   f. LA 1, Surge Arrestors.
   g. PB 1, Panelboards.
   h. ST 20, Dry-Type Transformers for General Applications.
   i. WD 1, General Requirements for Wiring Devices.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories, Inc. (UL):
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.

c. 198C, Standard for Safety High-Interrupting-Capacity Fuses, Current-Limiting Types.
d. 198E, Standard for Class Q Fuses.
e. 486E, Standard for Equipment Wiring Terminals.
f. 489, Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.
g. 508, Standard for Industrial Control Equipment.
h. 943, Standard for Ground-Fault Circuit Interrupters.
i. 1059, Standard for Terminal Blocks.
j. 1449, Standard for Transient Voltage Surge Suppression.
k. 1561, Standard for Dry-Type General-Purpose and Power Transformers.

1.2 SUBMITTALS

A. Shop Drawings:

1. Junction and pull boxes used at, or below, grade.
2. Large junction and pull boxes.
3. Panelboards and circuit breaker data.
4. Wiring devices.
5. Control devices.
6. Control relays.
7. Timers
8. Fuses.
9. Magnetic contactors.
10. Transformers.

B. Quality Control Submittals:

1. Test Report: Sound test certification for dry type power transformers (0 to 600-volt, primary).

1.3 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:

1. Box: Malleable iron.
2. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products:
   a. Crouse-Hinds; Type FS or FD.
   b. Appleton; Type FS or FD.

2.2 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Conduit Bodies Used as Junction Boxes: As specified under Article FITTINGS in Section 16110, RACEWAYS.

C. Large Sheet Steel Box:

1. NEMA 250, Type 1.
2. Box: Code-gauge, galvanized steel.
3. Cover: Full access, screw type.
4. Machine Screws: Corrosion-resistant.

D. Large Cast Metal Box:

1. NEMA 250, Type 12.
2. Box: Cast malleable iron, with drilled and tapped conduit entrances.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers, Surface Mounted Type:
   a. Crouse-Hinds; Series W.
   b. O.Z./Gedney; Series Y.
6. Manufacturers, Recessed Type:
   a. Crouse-Hinds; Type WJBF.
   b. O.Z./Gedney; Series YR.

2.3 WIRING DEVICES

A. Switches:

1. NEMA WD 1 and FS W-S-896E.

2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Color:
   a. All Areas: Ivory.
6. Integral grounding terminal on mounting strap.
7. Manufacturers:
   a. Arrow Hart.
   b. Bryant.
   c. Leviton.
   d. Hubbell.
   e. Pass and Seymour.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color:
   a. All Areas: Ivory.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. One piece mounting strap with integral ground contact.
8. Manufacturers:
   a. Arrow Hart.
   b. Bryant.
   c. Leviton.
   d. Hubbell.
   e. Pass and Seymour.
   f. Sierra.

C. Receptacle, Ground Fault Circuit Interrupter:

1. Duplex, specification grade, tripping at 5 mA.
2. Color: Ivory.
3. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps,.
4. Size: For 2-inch by 4-inch outlet boxes.
5. Standard Model: NEMA WD 1, with screw terminals and provisions for testing.

6. Feed-Through Model: NEMA WD 1, with feed-through screw terminals and provisions for testing.
7. Manufacturers:
   a. Pass and Seymour.
   b. Bryant.
   c. Leviton.
   d. Hubbell.
   e. Arrow Hart.

D. Switch, Motor Rated:

1. UL listed in category UL 508.
2. Quick-make, slow break contact design.
3. Silver alloy contacts.
4. Horsepower rated.
5. 2 hp (minimum) single-phase, 15 hp (minimum) three-phase, 480 volt.
6. Manufacturers:
   a. Arrow Hart.
   b. Hubbell.
   c. Square D.

2.4 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Malleable ferrous metal.
2. Screw: Oval-head stainless steel.

D. Weatherproof:

1. For Receptacles:
   a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.
   b. Mounting Screw and Cap Spring: Stainless steel.
   c. Manufacturers:
      1) Crouse-Hinds; Type WLRD -1.

2) Appleton; Type FSK-WRD

2. For Switches:
   a. Gasketed, cast-metal or -aluminum, incorporating external operator for internal switch.
   b. Mounting Screw: Stainless steel.
   c. Manufacturers:
      1) Crouse-Hinds; DS-181 or DS-185.
      2) Appleton; FSK-1VTS or FSK-1VS.

2.5 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) SYSTEM

A. The system operating voltage shall be 480/277 VAC, three-phase, four-wire plus ground. Unit shall be installed in parallel with the protected equipment. No series connected protective elements shall be used. Connection shall be made using low impedance manufacturer's cabling for maximum magnetic field cancellation.

B. Transient voltage surge suppression shall be provided for line to neutral, and neutral to ground. Total joule rating (8/20us waveform) to be 64,800 joules total. Peak suppression voltage (3kA-8/20us) 800V peak. (10kA-8/20us) 444 V peak.

C. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 400 kA. The surge life (8/20us) shall be at least 15 kA for 10,000 occurrences. The transient suppression capability shall be bi-directional and suppress both positive and negative impulses.

D. The suppressor shall be capable of interrupting a 65 kA, short circuit current delivered form the AC power line.

E. The suppressor shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.

F. Equipment shall be as manufactured by MCG Electronics or equal.

2.6 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB 1, NFPA 70, and UL 67.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: Applicable to a system with available short-circuit current as shown.

E. Cabinet:

1. NEMA 250, Type 1.
2. Material: Code-gauge, hot-dip galvanized sheet steel, with reinforced steel frame.
3. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
4. Front: Fastened with adjustable clamps.
   a. Trim Size:
      1) Surface Mounted: Same as box.
      2) Flush Mounted: 3/4-inch larger than box on all sides.
   b. Finish: Rust inhibitor prime, with manufacturer's standard baked enamel or lacquer.
5. Interior:
   a. Factory assembled, complete with circuit breakers.
   b. Capable of circuit breaker replacement without disturbing adjacent circuit breakers or without removing main bus.
   c. Spaces: Cover openings with easily removable metal cover.
6. Door Hinges: Concealed.
7. Locking Device:
      1) Flush type.
      2) Doors Over 30 Inches in Height: Multipoint.
      3) Identical keylocks, with two milled keys each lock.
8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

F. Bus Bar:

1. Material: Copper full sized throughout length.
2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
3. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
5. Lugs and Connection Points:
   a. Suitable for either copper or aluminum conductors.
   b. Solderless main lugs for main, neutral, and ground bus bars.
   c. Subfeed or through-feed lugs as shown.

6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

G. Circuit Breakers:

1. NEMA AB 1 and UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Noninterchangeable, in accordance with NFPA 70.
4. Locking: Provisions for handle padlocking, unless otherwise shown.
5. Type: Bolt-on circuit breakers in all panelboards.
6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
9. Ground Fault Interrupter:
   a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
   b. Sensor with same rating as circuit breaker and a push-to-test button.

H. Manufacturers:

1. Bryant.
2. Cutler-Hammer.
3. General Electric.
4. Gould I-T-E.
5. Square D.

2.7 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB 1, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multipole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: NEMA 250, Type as indicated in Part 3 of this Specification unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

2.8 FUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 98 listed for use and location of installation.

B. NEMA KS 1 and UL 98 Listed for application to system with available short-circuit current of 35,000 amps rms symmetrical.

C. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

F. Enclosure: NEMA 250, Type as indicated in Part 3 of this Specification unless otherwise shown.

G. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.9 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: NEMA 250, Type as indicated in Part 3 of this Specification unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.10 FUSE, 0 TO 600 VOLTS

A. Provide to fit mountings specified with switches and features to reject Class H fuses.

B. Motor and Transformer Circuits, 0- to 250-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPN-RK.
   b. Littelfuse; Type LLN-RK.

C. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Littelfuse; Type LLS-RK.

D. Feeder and Service Circuits, 0- to 250-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPN-RK.
   b. Littelfuse; Type LLN-RK.

2.11 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: Push-to-test.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.
3. Letter Height: 7/64-inch.

G. Manufacturers:

1. Heavy-Duty, Oiltight Type:
   a. General Electric; Type CR 104P.
   b. Square D; Type T.
   c. Cutler-Hammer; Type 10250T.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D; Type SK.
   b. General Electric; Type CR 104P.
   c. Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.

2.12 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.

2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller.
2. Ideal.
3. Electrovert.

2.13 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A300 (300 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:

1. Cutler-Hammer; Type M-300.
2. General Electric; Type CR120A.

2.14 MAGNETIC LIGHTING CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated by dual-acting, single coil mechanism.

C. Inherently interlocked and electrically held in both OPEN and CLOSED position.

D. Main Contacts:

1. Power driven in both directions.
2. Double-break, continuous-duty, rated 20 amperes, 600 volts, withstand rating of 22,000 amps rms symmetrical at 250 volts.
3. Marked for electric discharge lamps, tungsten, and general-purpose loads.

4. Position not dependent on gravity, hooks, latches, or semi-permanent magnets.
5. Capable of operating in any position.
6. Visual indication for each contact.

E. Auxiliary contact relay for two-wire control.

F. Provision for remote pilot lamp with use of auxiliary contacts.

G. Clamp type, self-rising terminal plates for solderless connections.

H. Enclosure: NEMA 250, Type 1, General-Purpose, unless otherwise shown.

I. Manufacturers:

1. ASCO.
2. Westinghouse; Class A202.
3. General Electric; Class 360.

2.15 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Self-cooled, two-winding.

C. Insulation Class and Temperature Rise: Manufacturer's standard.

D. Core and Coil:

1. Encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

E. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

F. Enclosure:

1. Single-Phase, 3 to 25 kVA: NEMA 250, Type 3R, nonventilated.
2. Three-Phase, 3 to 15 kVA: NEMA 250, Type 3R, nonventilated.
3. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.

G. Wall Bracket: For single-phase units, 15 to 37-1/2 kVA, and for three-phase units, 15 to 30 kVA.

H. Voltage Taps:

1. Single-Phase, 3 to 10 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity, two above and two below normal voltage rating.
3. Three-Phase, 3 to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity, two above and two below normal voltage rating.

I. Impedance: 4.5 percent minimum on units 75 kVA and larger.

J. Maximum Sound Level: NEMA ST 20:

1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.
3. 50 decibels for 51 to 150 kVA.

K. Vibration Isolators:

1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

L. Manufacturers:

1. General Electric.
2. Square D.
3. Westinghouse.

2.16 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12-gauge, ASTM A570, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063-T6 aluminum alloy.

2. Fittings fabricated from Alloy 5052-H32.

C. Manufacturers:

1. B-Line.
2. Unistrut.
3. Aickinstrut.

2.17 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:

1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:

1. Pushbuttons/Selector Switches: 1/8-inch.
2. Panelboards: 1/4-inch.

PART 3 EXECUTION

3.1 GENERAL

A. Install equipment in accordance with NECA 5055.

3.2 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.

3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by COTR/CM.
3. Light Switch: Install on lock side of doors.
4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by COTR/CM.
2. Light Switch: 48 inches above floor.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
5. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above counter tops without splashback.
   c. Industrial Areas, Workshops: 48 inches above floor.
   d. Outdoor, All Areas: 24 inches above finished grade.
6. Switch, Motor Starting: 48 inches above floor unless otherwise indicated on the drawings.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install galvanized mounting hardware in industrial areas.

M. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

N. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

O. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

P. Box Type (Steel Raceway System):

1. Exterior Locations:
   a. Exposed Raceways: Cast metal.
   b. Concealed Raceways: Cast metal.
   c. Concrete Encased Raceways: Cast metal.
2. Interior Dry Locations:
   a. Exposed Rigid Conduit: Sheet steel.
   b. Exposed EMT: Sheet steel.
   c. Concealed Raceways: Sheet steel.
   d. Concrete Encased Raceways: Cast metal.
   e. Lighting Circuits, Ceiling: Sheet steel.
3. Cast-In-Place Concrete Slabs: Sheet steel.

Q. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

3.3 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

F. Installed boxes shall be accessible.

G. Do not install on finished surfaces.

H. Install plumb and level.

I. Support boxes independently of conduit by attachment to building structure or structural member.

J. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

K. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

L. Boxes embedded in concrete or masonry need not be additionally supported.

M. At or Below Grade:

1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain COTR/CM's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

N. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

O. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.

P. Location/Type:

1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Underground Conduit: Concrete.
3. Wet or Outdoor Locations: NEMA 250, Type 3R, Outdoor.

3.4 WIRING DEVICES

A. Switches:

1. Mounting Height: See Article OUTLET AND DEVICE BOXES.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot down.
2. Weatherproof Receptacles:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.
3. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.
4. Special-Purpose Receptacles: Install in accordance with manufacturer’s instructions.

C. Multioutlet Surface Raceway System:

1. Install in accordance with manufacturer’s instructions.
2. Wire alternate outlets to each circuit where two-circuit, three-wire supply is shown.

D. Switch, Motor Rated:

1. Install with switch operation in vertical position such that toggle is in up position when ON.
2. Install within sight of motor when used as a disconnect switch.
3. Mounting Height: See Article OUTLET AND DEVICE BOXES.

4. Enclosure Type: See Article OUTLET AND DEVICE BOXES.

3.5 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16-inch.

E. Types (Unless Otherwise Shown):

1. Office: Metal.
2. Exterior: Weatherproof.
3. Interior:
   a. Flush Mounted Boxes: Metal.
   b. Surface Mounted, Metal Boxes**:**
      1) General Purpose Areas: Sheet Steel.
      2) Other Areas: Cast.
   c. Surface Mounted, Aluminum Boxes:
      1) General Purpose Areas: Stamped.
      2) Other Areas: Cast.
   d. Surface Mounted, Sheet Steel Boxes: Raised sheet steel.

3.6 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, Oiltight Type: Locations (Unless Otherwise Shown): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown): Nonhazardous, outdoor, or normally wet areas.
2. Mounting: NEMA 250, Type 4X enclosure.

3.7 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) SYSTEM

A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.

B. Units shall be installed as close as possible to the panelboard to which it is connected—preferably within 2 feet of the panelboard and using low impedance, manufacturer's cabling.

3.8 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

D. Cabinet Location/Type:

1. General Use in Finished Areas: NEMA 250, Type 1.
2. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

3.9 CIRCUIT BREAKER, FUSED SWITCH, AND NON-FUSED SWITCH ENCLOSURES

A. Location/Type:

1. Wet: NEMA 250, Type 4.
2. Industrial Use: NEMA 250, Type 12.
3. General Purpose: NEMA 250, Type 1.
4. Where denoted WP: NEMA 250, Type 3R.

3.10 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moistureproof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

3.11 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Type:

1. Interior, Wet or Dry Locations:
   a. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.
   b. Aluminum Raceway: Extruded aluminum.
2. Outdoor, Locations:
   a. Steel Raceway: Carbon steel or paint coated framing channel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.
2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.

END OF SECTION

SECTION 16110
RACEWAYS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.
2. American National Standards Institute (ANSI).
3. American Society for Testing and Materials (ASTM).
4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
5. National Electrical Manufacturers Association (NEMA).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories, Inc. (UL).

1.2 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's Literature:
   a. Rigid galvanized steel conduit.
   b. Electric metallic tubing.
   c. PVC Schedule 40 conduit.
   d. Flexible metal, liquid-tight conduit.
   e. Flexible metal, nonliquid-tight conduit.
   f. Conduit fittings.
   g. Wireways.
2. Cable Tray Systems:
   a. Dimensional drawings, calculations, and descriptive information.
   b. NEMA load/span designation and how it was selected.
   c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
   d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
   e. Layout drawings and list of accessories being provided.
3. Conduit Layout:
   a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
      1) Low and medium voltage feeder and branch circuits.

2) Instrumentation and control systems.
3) Communications systems.
4) Empty conduit for future use.

b. Reproducible mylar; scale not greater than 1-inch equals 20 feet.

4. Equipment and machinery proposed for bending metal conduit.
5. Method for bending PVC conduit less than 30 degrees.

1.3 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of ANSI C80.1 and UL6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. Electric Metallic Tubing (EMT):

1. Meet requirements of ANSI C80.3 and UL 797.
2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

C. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

E. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 1.
2. Material: Galvanized steel.

F. Innerduct: Plenum rated innerduct (UL 910), corrugated, 1-1/4-inch diameter, with pull cord.

2.2 FITTINGS

A. Rigid Galvanized Steel:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers:
      1) Thomas & Betts; Type BIM.
      2) O.Z. Gedney; Type HB.
3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers:
      1) Appleton; Series GIB.
      2) O.Z. Gedney; Type HBLG.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. Manufacturers:
      1) O.Z. Gedney; Series CH.
      2) T & B; Series 400.
5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers (For Normal Conditions):
      1) Appleton; Form 35 threaded Unilets.
      2) Crouse-Hinds; Form 7 or 8 threaded condulets.
      3) Killark; Series O Electrolets.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot dip galvanized, malleable iron.
   b. Manufacturers:
      1) O-Z/ Gedney Type SSP or type 4 series.
      2) Raco hinged coupling or three piece coupling.
8. Expansion Fitting Manufacturers:
   a. Deflection/Expansion Movement:
      1) Appleton; Type DF.
      2) Crouse-Hinds; Type XD.
   b. Expansion Movement Only:
      1) Appleton; Type XJ.
      2) Crouse-Hinds; Type XJ.

9. Cable Sealing Fittings:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2-inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers:
        1) Crouse-Hinds; CGBS.
        2) Appleton; CG-S.

B. Electric Metallic Tubing:

1. Meet requirements of UL 514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Compression Ring: Stainless steel.
4. Coupling Manufacturers:
    a. Appleton; Type 95T.
    b. Crouse-Hinds; Type CPR.
5. Connector Manufacturers:
    a. Appleton; Type 86T.
    b. Crouse-Hinds; Type CPR.

C. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.
2. Type: PVC, slip-on.

D. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Manufacturers:
    a. T & B; Series 5331.
    b. O.Z. Gedney; Series 4Q.

E. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 514B.
2. Body: Galvanized steel.
3. Throat: Nylon insulated.
4. 1-1/4-Inch Conduit and Smaller: One screw body.
5. 1-1/2-Inch Conduit and Larger: Two screw body.
6. Manufacturer: Appleton, Series 7400.

F. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer: O.Z. Gedney; Type FSK or WSK, as required.
2. Cored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Manufacturer: O.Z. Gedney; Series CSM.

2.3 METAL WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Indoor.

D. Finish: Gray, baked enamel.

E. Manufacturers:

1. Square D.
2. B-Line Systems, Inc.

2.4 CABLE TRAYS

A. Meet requirements of NEMA VE 1.

B. Type: Ladder, of welded construction.

C. Material: Copper-free aluminum alloy 6063-T6 finish.

D. Dimensions: As shown on Drawings with 12-inch bending radius.

E. Fittings of same cross-sectional tray area, and hardware of same material as cable tray.

F. Tray Grounding: Conform to NFPA 70 and NEMA VE 1.

G. Provide next higher NEMA VE 1 class designation than required for support of designed span length.

H. Design Loads: Use working load adequate for actual cable installed plus 20 percent additional weight allowance for future cables plus 200-pound concentrated static load applied between side rails at midspan, with safety factor of 1.5 in accordance with NEMA VE 1, Table 3-1.

I. Furnish Cable Tray with no sharp edges, burrs, or weld projections.

J. Manufacturers:

1. B-Line Systems, Inc.
2. Square–D.
3. P.W. Industries.

2.5 ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturer:
   a. Underground Device, Inc.
   b. Carlon.

B. Identification Devices:

1. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge.
   b. Color: Red.
   c. Width: Minimum 6-inch.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Manufacturers:
      1) Blackburn, Type RT.
      2) Griffolyn Co.

C. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Manufacturer: Raychem; Type TWDB.

PART 3 EXECUTION

3.1 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Group raceways installed in same area.

G. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

H. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

I. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

J. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

K. Install watertight fittings in outdoor, underground, or wet locations.

L. Paint threads and cut ends, before assembly of fittings, of galvanized conduit, PVC coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

M. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

N. Do not install raceways in concrete equipment pads, foundations, or beams.

O. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

P. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.2 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 2 inches, including all fittings.

B. Conduit placement shall not require changes in reinforcing steel location or configuration.

C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

D. Conduit larger than 1-inch shall not be embedded in concrete slabs, walls, foundations, columns or beams unless approved by COTR/CM.

E. Slabs and Walls:

1. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
2. Install within middle two-fourths of slab or wall.
3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1-inch.
6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams:

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.3 CONDUIT APPLICATION

A. Diameter: Minimum 3/4-inch.

B. Exterior, Exposed: Rigid galvanized steel.

C. Interior, Exposed: Electric metallic tubing.

D. Interior, Concealed (Not Embedded in Concrete): Electric metallic tubing.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: Electric metallic tubing.

F. Direct Earth Burial: Rigid galvanized steel.

G. Concrete-Encased Raceways: PVC Schedule 40.

H. Under Slabs-On-Grade: Rigid galvanized steel.

3.4 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet or Corrosive Areas: Flexible metal, liquid-tight.
4. Dry Areas: Flexible, metallic liquid-tight.
5. Length: 18-inch minimum, 60-inch maximum, sufficient to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground or Concrete Embedded to Exposed: Rigid galvanized steel.

E. Under Equipment Mounting Pads: Rigid galvanized steel.

3.5 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.

2. Concrete Roof or Membrane Waterproofed Wall or Floor:
   a. Provide a watertight seal.
   b. Without Concrete Encasement: Install watertight entrance seal device on each side.
   c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
   d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
   e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by manufacturer.
   b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
   c. Seal penetration with silicone type sealant as specified in Section 07900, JOINT SEALANTS, Type 11.

3.6 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze.

C. Application/Type of Conduit Strap:

1. Rigid Steel or EMT Conduit: Zinc coated steel, pregalvanized steel or malleable iron.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.
5. Location/Type of Hardware:
   a. Dry, Noncorrosive Areas: Galvanized.
   b. Wet, Noncorrosive Areas: Stainless steel.
   c. Corrosive Areas: Stainless steel.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.7 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30-Degree and Larger: Provide factory-made elbows.
2. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.8 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 25 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.9 PVC CONDUIT

A. Solvent Welding:

1. Provide manufacturer recommended solvent; apply to all joints.
2. Install such that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.10 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

C. Applications:

1. Metal wireway in indoor dry locations.
2. Non-metallic wireway in indoor wet, outdoor, and corrosive locations.

3.11 CABLE TRAYS

A. Install in accordance with Application Information Section of NEMA VE 1.

B. Provide accessories as necessary for a complete system.

C. Install such that joints are not made at support brackets.

D. Install horizontal section support brackets between support point and quarter point of tray span.

E. Provide ceiling trapeze for all horizontal cable tray.

F. Install horizontal tray level, plumb, straight, and true to line or grade within a tolerance of 1/8-inch in 25 feet and within a cumulative maximum of 1/2-inch.

G. Install vertical tray plumb within a tolerance of 1/8-inch in 20 feet.

H. Install without exposed raw edges.

I. Provide bonding jumper at each expansion joint and adjustable connection.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. NEMA 4 and 4X Boxes, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. Rigid Galvanized:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
   d. Install insulated bushing on ends of conduit where grounding is not required.
   e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   f. Utilize sealing locknuts on outside of NEMA 3R and NEMA 12 enclosures.
2. Electric Metallic Tubing: Provide gland compression, insulated connectors.
3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.

D. Panelboard, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.13 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Reinforcing bars required at joints and entrances to structures.

C. Cover: Maintain minimum 2-foot cover above concrete encasement, unless otherwise shown.

D. Make routing changes as necessary to avoid obstructions or conflicts.

E. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

F. Union type fittings not permitted.

G. Spacers:

1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

H. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

I. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. Duct Bank Reinforced Concrete: Minimum concrete compressive strength shall be 2,500 psi at 28 days. Maximum nominal aggregate size used shall be 1 inch, water/cement ratio shall be 0.50. Reinforcement shall be ASTM A615 Grade 60 deformed bars.

K. Backfill: As specified in Section 02225, TRENCH BACKFILL.

3.14 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.15 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

END OF SECTION

SECTION 16120
CONDUCTORS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
2. American Society for Testing and Materials (ASTM):
   a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-Plated Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B263, Standard Test Method for Determination of Cross-Sectional Area of Stranded Conductors.
3. Association of Edison Illuminating Companies (AEIC):
   a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.
   b. CS 6, Ethylene-Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.
4. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test With a Theoretical Heat Input of 210,000 Btu/hour.
5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.
   b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.
6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.
7. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 3, Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   d. WC 7, Crosslinked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

e. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
f. WC 55, Instrumentation Cables and Thermocouple Wire.

8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
9. Underwriters Laboratories, Inc. (UL):
   a. 13, Standard for Safety Power-Limited Circuit Cables.
   b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
   c. 62, Standard for Safety Flexible Cord and Fixture Wire.
   d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.
   e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
   f. 510, Standard for Safety Insulating Tape.
   g. 854, Standard for Safety Service-Entrance Cables.
   h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
   i. 1072, Standard for Safety Medium-Voltage Power Cables.
   j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.2 SUBMITTALS

A. Shop Drawings:

1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.

B. Quality Control Submittals:

1. Factory Test Report for conductors 600 volts and below.
2. Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.3 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:

1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN.

D. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

2.2 CONDUCTORS ABOVE 600 VOLTS

A. EPR Insulated Cable:

1. Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.
2. Type: 15 kV, shielded, UL 1072, Type MV-90.
3. Conductors: Copper, concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B263.
4. Strand Fill: Waterproof strand compound enclosing all conductors.
5. Conductor Screen: Extruded, semiconducting ethylene-propylene rubber in accordance with NEMA WC 8 and AEIC CS 6.
6. Insulation: 133 percent insulation level, ethylene-propylene rubber (EPR), containing no polyethylene in accordance with NEMA WC 8, and AEIC CS 6.
7. Insulation Thickness: 220-mil, 15 kV, nominal.
8. Insulation Screen: Thermosetting, semiconducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 8, and AEIC CS 6.
9. Metallic Shield: Uncoated, 5-mil, copper shielding tape, helically applied with 12-1/2 percent minimum overlap.
10. Jacket: Extruded polyvinyl chloride (PVC) compound applied over the metallic shield in accordance with NEMA WC 8.
11. Operating Temperature: 90 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.
12. Manufacturers:
    a. Okonite Co.
    b. Pirelli Wire and Cable.
    c. Cablec Corp.
    d. Southwire Co.

2.3 600-VOLT RATED CABLE

A. General:

1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

2.4 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.5 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer
   b. Manufacturers and Products:
      1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      2) Plymount; Plyarc 30, with Plymount Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.

3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. Plated steel, square wire springs.
   b. UL Standard 486C.
   c. Manufacturers and Product:
      1) Thomas & Betts.
      2) Ideal; Twister.
4. Self-Insulated, Set Screw Wire Connector:
   a. Two piece compression type with set screw in brass barrel.
   b. Insulated by insulator cap screwed over brass barrel.
   c. Manufacturer: 3M

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Insulated, Locking-Fork, Compression Lugs:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Seamless.
   c. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) ILSCO; ILSCONS.
4. Uninsulated Crimp Connectors and Terminators:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Manufacturers and Products:
      1) Square D; Versitide.
      2) Thomas & Betts; Color-Keyed.
      3) ILSCO.

5. Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Manufacturers and Products:
      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized, crosslinked polyolefin.
2. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.6 ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS

A. Molded Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
2. Capable of making splices that have a current rating equal to, or greater than the cable ampacity, conforming to IEEE 404.
3. 15 kV class, with compression connector, EPDM molded semiconductive insert, peroxide-cured EPDM insulation, and EPDM molded semiconductive outer shield.
4. Premolded splice shall be rejacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.
5. Manufacturers:
   a. Elastimold.
   b. Cooper Industries.

B. Termination Kits:

1. Capable of terminating a 15 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
2. Capable of producing a termination with a current rating equal to, or greater than, the cable ampacity, meeting Class 1 requirements of IEEE 48.
3. Capable of accommodating any form of cable shielding or construction without the need for special adapters and/or accessories.
4. Manufacturers:
   a. Raychem.
   b. 3M Co.

C. Elbow Connector Systems:

1. Molded, peroxide-cured, EPDM-insulated, 15 kV class, 95 kV BIL, 200A, 10,000A rms load-break and 600A, 40,000 rms nonload-break elbows having all copper current-carrying parts in accordance with ANSI 386.
2. Protective Caps: 15 kV class, 95 kV BIL, 200 amperes, with molded EPDM insulated body.
3. Insulated Standoff Bushings: 15 kV class, 95 kV BIL, 200 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
4. Bushing Inserts: 15 kV class, 95 kV BIL, 200A, load-break with EPDM rubber body and all-copper, current-carrying parts.
5. Manufacturers:
   a. Cooper Industries.
   b. Elastimold.

D. Cable Lugs:

1. In accordance with NEMA CC1.
2. Rated 15 kV of same material as conductor metal.
3. Manufacturers and Products, Uninsulated Crimp Connectors and Terminators:
   a. Square D; Versitide.
   b. Thomas & Betts; Color-Keyed.
   c. ILSCO.
4. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Thomas & Betts; Locktite.
   b. Brundy; Quiklug.
   c. ILSCO.

2.7 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:

1. Ideal Co.; Yellow 77.

2. Polywater, Inc.
3. Cable Grip Co.

2.8 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

B. Conductors Above 600 Volts: Test in accordance with NEMA WC 8 and AEIC CS 6 partial discharge level test for EPR. insulated cable.

PART 3 EXECUTION

3.1 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

3.2 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.

2. No. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

B. Conductors Above 600 Volts: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.

1. Colors:
   a. Grounded Neutral: White.
   b. Phase A: Brown.
   c. Phase B: Orange.
   d. Phase C: Yellow.

3.3 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
2. Cables, and Conductors No. 2 AWG and Larger:
   a. Identify with marker plates.
   b. Attach marker plates with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.4 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by COTR/CM.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors No. 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on motor circuit conductors No. 10 AWG and larger.
7. Tape insulate all uninsulated connections.
8. Place no more than one conductor in any single-barrel pressure connection.
9. Install crimp connectors with tools approved by connector manufacturer.
10. Install terminals and connectors acceptable for type of material used.
11. Compression Lugs:
    a. Attach with a tool specifically designed for purpose.
    b. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Indoors: Use general purpose, flame retardant tape.
2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

3.5 CONDUCTORS ABOVE 600 VOLTS

A. Do not splice unless specifically indicated or approved by the COTR/CM.

B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer's instructions.

C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer nontracking insulation tubings, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing.

E. Install terminals or connectors acceptable for type of conductor material used.

F. Provide shield termination and grounding for all terminations.

G. Provide necessary mounting hardware, covers, and connectors.

H. Where elbow connectors are specified, install in accordance with manufacturer's instructions.

I. Connections and Terminations:

1. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
2. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
3. Install uninsulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.

J. Give 2 working days notice to COTR/CM prior to making splices or terminations.

3.6 CONDUCTOR ARC AND FIREPROOFING

A. Install arc and fireproofing tape on 15 kV cables throughout their entire exposed length in manholes, handholes, vaults, cable trays, and other indicated locations.

B. Wrap conductors of same circuit entering from separate conduit together as a single cable.

C. Follow tape manufacturer's installation instructions.

D. Secure tape at intervals of 5 feet with bands of tapebinder. Each band to consist of a minimum of two wraps directly over each other.

3.7 FIELD QUALITY CONTROL

A. In accordance with Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16450
GROUNDING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.2 SUBMITTALS

A. Shop Drawings:

1. Product Data:
   a. Exothermic weld connectors.
   b. Mechanical connectors.
   c. Compression connectors.

1.3 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 GROUND ROD

A. Material: Copper-clad.

B. Diameter: Minimum 5/8-inch.

C. Length: 10 feet.

2.2 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.3 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.
   b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.
   c. Ilso Corp.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.

PART 3 EXECUTION

3.1 GENERAL

A. Grounding shall be in compliance with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

3.2 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.3 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.4 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.5 CONNECTIONS

A. General:

1. Abovegrade Connections: Use either exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.6 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.7 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.8 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of pad-mounted transformers to two locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.9 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.10 FIELD QUALITY CONTROL

A. As specified in Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16465
OIL-FILLED PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   b. C57.12.22, Transformers: Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller.
   c. C57.12.26, Transformers: Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors.
   d. C57.12.28, Switchgear and Transformers: Pad-Mounted Equipment-Enclosure Integrity.
   e. C57.12.90, Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers.
   f. C62.11, Standard for Metal-Oxide Surge Arresters for AC Power Circuits.
   g. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   h. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.

1.2 SUBMITTALS

A. Shop Drawings:

1. Descriptive information.
2. Dimensional drawings.
3. Transformer nameplate data.
4. Schematic and connection diagrams.

B. Quality Control Submittals:

1. Operation and maintenance manual.
2. Factory test reports.

1.3 QUALITY ASSURANCE

A. Design, test, and assemble in accordance with applicable standards of ANSI C57.12.00, C57.12.22, C57.12.26, and C57.12.90.

1.4 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage, the following spare parts:

1. One quart of paint to match color and quality of equipment final shop finish.
2. One spare fuse link for each fuse size.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cutler Hammer.

B. Square D Co.

C. General Electric.

D. Cooper Power System.

2.2 GENERAL

A. Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.

B. Anchor Bolts: Galvanized.

2.3 TRANSFORMER

A. kVA Rating: As shown.

B. Primary Voltage: 12.47 kV line-to-line, three-phase, 60-Hz, unless otherwise indicated.

C. Secondary Voltage: as shown, 60-Hz.

D. BIL Rating:

1. 95 BIL for 15 kV insulation class transformers.
2. 30 BIL for secondary.

E. Temperature Rise: 65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.

F. Impedance:

1. 1.35 percent minimum for transformers rated 150 kVA and less.
2. 3.0 percent minimum for transformers rated 225, 300, and 500 kVA.
3. 5.75 percent for transformers rated 750 kVA and above.

G. Coolant: Normally formulated, hydro-refined oil, free of PCB chemicals.

H. Primary Taps:

1. Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.
2. Externally operated no-load tap changer.
3. Provisions for locking handle in any position.

I. Coil Conductors: Aluminum windings.

J. Sound Level: In accordance with manufacturer's standards.

2.4 ENCLOSURE

A. In accordance with ANSI C57.12.28 requirements.

B. Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes.

C. 12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners which are externally removable.

D. Color: Scott AFB standard—Brod-Dugan “expresso” brown.

2.5 TERMINAL COMPARTMENTS

A. General: ANSI C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.

1. Doors:
   a. Individual, full-height, air-filled.
   b. Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.
   c. High voltage door fastenings unaccessible until low voltage door has been opened.
   d. Door Bolts: Penta-head type.
   e. Lift-off, stainless steel hinges and door stops.

f. Removable front sill to facilitate rolling or skidding over conduit stubs.
g. Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.

B. High Voltage Compartment:

1. Deadfront in accordance with ANSI C57.12.26 type construction.
2. Protective fuses.
3. High voltage bushings.
4. Transformer grounding pad.
5. Surge arresters.

C. Low Voltage Compartment:

1. Livefront in accordance with ANSI C57.12.26 type construction.
2. Low voltage bushings.
3. Grounding pad.
4. Stainless steel equipment nameplate.
5. Liquid level gauge.
6. 1-inch upper filter press and filling plug.
7. Drain valve with sampling device.
8. Dial type thermometer.
9. Pressure relief valve.
10. Nameplate.

2.6 BUSHINGS

A. High Voltage:

1. Deadfront Termination:
   a. Universal bushing well rated at 15 kV in accordance with ANSI 386.
   b. Bushings externally clamped and front removable.
   c. Rated for 200 amperes continuous, 95 kV BIL.
   d. Standoff brackets located adjacent to bushings.

B. Low Voltage:

1. Molded epoxy bushing clamped to tank with 4 hole spade type terminals.
2. Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.
3. Internally connected neutral extending to neutral bushing.

2.7 HIGH VOLTAGE PROTECTION

A. Combination Oil-Immersed Bayonet Expulsion and Current Limiting Fuses:

1. Accessibility:
   a. Bayonet expulsion fuse accessible through primary compartment.
   b. Current-limiting fuse accessible through tank handhole.
2. Current Limiting for High Current Faults: Interrupting capacity of 50,000 amperes rms symmetrical.
3. Bayonet fuse externally replaceable with hot stick.

2.8 SURGE ARRESTERS

A. Metal-Oxide, Varistor Type:

1. Insulated body, elbow type, 9 kV in accordance with ANSI C62.11.
2. Installed in high voltage compartment.
3. Connected to transformer high voltage terminals.

2.9 TANK GROUNDING PADS

A. High and Low Voltage Compartments: Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

2.10 TAP CHANGER WARNING SIGN

A. Red laminated plastic, engraved to white core.

B. Engrave to read DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

C. Mount above tap changer handle.

2.11 FACTORY TESTS

A. Production tests in accordance with ANSI C57.12.90 and C57.12.00, Section 8 and Table 16.

B. Dielectric test in accordance with ANSI C57.12.26.

PART 3 EXECUTION

3.1 GENERAL

A. Secure to mounting pads with anchor bolts.

B. Install plumb and longitudinally in alignment with pad or adjacent building wall.

C. Ground neutrals and enclosures in accordance with applicable codes.

3.2 FIELD QUALITY CONTROL

A. In accordance with Section 16950, ELECTRICAL TESTING.

3.3 ADJUSTMENTS

A. Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

END OF SECTION

SECTION 16500
LIGHTING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
3. Underwriters Laboratories, Inc. (UL): 924, Standard for Safety Emergency Lighting and Power Equipment.

1.2 SUBMITTALS

A. Shop Drawings:

1. Interior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. Candle power distribution curves in two or more planes.
   e. Candle power chart 0 to 90 degrees.
   f. Lumen output chart.
   g. Coefficients of utilization for zonal cavity calculations.
   h. Mounting or suspension details.
2. Exterior Luminaires:
   a. Catalog data sheets and pictures.
   b. Luminaire finish and metal gauge.
   c. Lens material, pattern, and thickness.
   d. IES lighting classification and isolux diagram.
   e. Fastening details to wall or pole.
   f. Ballast type, location, and method of fastening.
3. Lamps:
   a. Voltages.
   b. Colors.
   c. Approximate life (in hours).
   d. Approximate initial lumens.
   e. Lumen maintenance curve.
   f. Lamp type and base.
4. Ballasts:
   a. Type.
   b. Wiring diagram.
   c. Nominal watts and input watts.

d. Input voltage and power factor.
e. Starting current, line current, and restrike current values.
f. Sound rating.
g. Temperature rating.
h. Efficiency ratings.
i. Low temperature characteristics.
j. Emergency ballasts rating and capacity data.

5. Photo Control:
   a. Wiring diagram.
   b. Contact ratings.
6. Occupancy Sensors:
   a. Type.
   b. Switching capability.
   c. Coverage.
   d. Time delay AUTO/OFF adjustment.

1.3 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Specific requirements relative to execution of Work of this section are located in the Luminaire Schedule on Drawings.

B. Feed-through type, or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Soffit Installations:

1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.
2. Ballast: Removable, prewired.

H. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.
2. Ballast: Removable, prewired.

3. When factory-installed photocells are provided, entire assembly shall have UL label.

I. Emergency Lighting:

1. Power Pack: Self-contained, 120/277-volt selectable input transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
2. Lighted, push-to-test indicator.
3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
5. Capable of protecting against excess charging and discharging.

2.2 LAMPS

A. Fluorescent:

1. Type Efficiency: Energy.
2. Color: Cool white.

B. High Intensity Discharge:

1. Type: High pressure sodium and metal halide.
2. Color: Clear.

C. Incandescent:

1. Type Efficiency: Energy.
2. Color: Inside frosted.

D. Manufacturers:

1. General Electric.
2. Sylvania.
3. North American Phillips.

2.3 BALLASTS

A. General:

1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
2. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.

3. For use in exterior located ballasts to produce reliable starting of lamps at minus 20 degrees F at 90 percent of nominal line voltage.

B. Fluorescent:

1. Type: High power factor, energy efficient, electronic type ballast, compatible with lamps specified.
2. Sound Rating: Minimum A, maximum allowable noise level of 30 decibels measured 2-feet from installed fixture.
3. Class: P.
4. Automatic resetting, thermo-protector to prevent case temperature from exceeding 110 degrees C in the event of a short circuit.

C. High Pressure Sodium and Metal Halide:

1. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and ignitor.
2. Type:
   a. Autotransformer for 50-watt lamps.
   b. Constant wattage autotransformer for lamps 70 watts and above.

D. Manufacturers:

1. MagneTek Jefferson.
2. Advance Transformer.
3. Universal.

2.4 LIGHTING CONTROL

A. Photocell:

1. Automatic ON/OFF switching photo control.
2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
3. Setting: ON at dusk and OFF at dawn.
4. Time delay feature to prevent false switching.
5. Field adjustable to control operating levels.
6. Manufacturers:
   a. Tork.
   b. Paragon.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters.

1. Control: Continuously adjustable slide, toggle, or rotary knob. Single-pole or three-way switch to suit connections.
2. Incandescent Lamp Dimmers: Modular, 120V, 60 Hz with continuously adjustable rotary knob, toggle, or slide; single pole with soft tap or other

quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.

2.5 EMERGENCY BALLAST

A. In accordance with UL 924.

B. Nickel cadmium battery, charger, and electronic circuitry in metal case.

C. Solid state charging indicator monitoring light and double-pole test switch.

D. Capable of operating fluorescent lamps for a period of 90 minutes with output of 1,100 to 1,200 lumens.

E. Manufacturers:

1. MagneTek Jefferson.
2. Bodine.
3. Radiant.

PART 3 EXECUTION

3.1 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
4. Install plumb and level.
5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:

1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48-inches apart.
3. Provide twin-stem hangers on single luminaires.

C. Swinging Type: Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

D. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2-inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
5. Junction Boxes:
   a. Flush and Recessed Luminaires: Locate minimum 1-foot from luminaire.
   b. In concealed locations, install junction boxes to be accessible by removing luminaire.
6. Wiring and Conduit:
   a. Provide wiring of temperature rating required by luminaire.
   b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
   a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
   b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
   c. Fasten chain or wire to each end of luminaire.

E. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

A. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

3.3 BALLASTS

A. Install in accordance with manufacturer's recommendations.

B. Utilize all ballast mounting holes to fasten securely within luminaire.

C. Replace noisy or defective ballasts.

3.4 LIGHTING CONTROL

A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

3.5 EMERGENCY BALLAST

A. Install battery, charger, and electronic circuitry metal case inside fluorescent fixture housing.

B. Install monitoring light and double-pole switch adjacent to light fixture.

3.6 CLEANING FOLLOWING CONSTRUCTION

A. Remove all labels and other markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace all *defective* lamps at time of Substantial Completion.

END OF SECTION

SECTION 16720
FIRE ALARM SYSTEM, ADDRESSABLE

PART 1 GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American National Standards Institute (ANSI): ANSI S3.41, (1990; R 1996) Audible Emergency Evacuation Signal.
2. Code of Federal Regulations (CFR): 47 CFR 15, Radio Frequency Devices.
3. Factory Mutual Engineering and Research (FM): FM P7825a, (1998) Approval Guide Fire Protection.
4. Institute of Electrical and Electronics Engineers (IEEE): IEEE C62.41, (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits.
5. National Fire Protection Association (NFPA):
   a. NFPA 70, (1999) National Electrical Code.
   b. NFPA 72, (1996; Errata Oct 96, Dec 96; TIA 96-1, 96-2, 96-3) National Fire Alarm Code.
   c. NFPA 90A, (1996) Installation of Air Conditioning and Ventilating Systems.
   d. NFPA 1221, (1994) Installation, Maintenance and Use of Public Fire Service Communication Systems.
6. Underwriters Laboratories (UL):
   a. UL 6, (1997) Rigid Metal Conduit.
   b. UL 38, (1994; Rev Nov 1994)) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems.
   c. UL 228, (1997) Door Closers-Holders, With or Without Integral Smoke Detectors.
   d. UL 268, (1996; Rev thru Jun 1998) Smoke Detectors for Fire Protective Signaling Systems.
   e. UL 268A, (1998) Smoke Detectors for Duct Applications.
   f. UL 464, (1996; Rev May 1997) Audible Signal Appliances
   g. UL 521, (1993; Rev Oct 1994) Heat Detectors for Fire Protective Signaling Systems.
   h. UL 632/ANSI C33.41, (1994; Rev Sep 1994) Electrically-Actuated Transmitters.
   i. UL 797, (1993; Rev thru Mar 1997) Electrical Metallic Tubing.
   j. UL 864, (1996) Control Units for Fire-Protective Signaling Systems.
   k. UL 1242, (1996; Rev Mar 1998) Intermediate Metal Conduit

l. UL 1971, (1995; Rev thru May 1997) Signaling Devices for the Hearing Impaired.

1.2 GENERAL REQUIREMENTS

A. This specification is based on an original fire alarm system specification for the Flight Simulator Building. It is intended to establish provisions and guidelines for the Contractor to add the necessary equipment and operational functions to the existing system. There may be equipment specified herein, which may not be required for this addition. The Contractor shall coordinate the new and existing equipment requirements for the Flight Training Unit addition with the drawings for a complete and operable system.

B. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

C. Nameplates: Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

D. Tags: Tags with stamped identification number shall be furnished for keys and locks.

E. Verification of Dimensions: After becoming familiar with details of the work, the CONTRACTOR shall verify dimensions in the field and shall advise the COTR/CM of any discrepancy before performing the work.

F. Compliance: The fire detection and alarm system and the central reporting system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the COTR/CM. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

G. Qualifications:

1. Engineer and Technician:
   a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.
   b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm

systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

2. Installer: The installing Contractor shall provide the following: The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the Drawings.

1.3 SYSTEM DESIGN

A. Operation: The fire alarm and detection system shall be a complete, supervised fire alarm system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to initiating device circuits (IDC), Style D, to signal line circuits (SLC), Style 5, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, NAC, or SLC will remain functional. Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 volts dc. The existing addressable system is microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and has the following features:

1. Sufficient memory to perform as specified and as shown for addressable system.
2. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and appliances missing/failed remote detector—sensitivity adjustment from the panel for smoke detectors.
3. Capability of each addressable device being individually disabled or enabled from the panel.
4. Each SLC shall be sized to provide 40 percent addressable expansion without hardware modifications to the panel.

B. Operational Features: The system shall have the following operating features:

1. Monitor electrical supervision of IDC, SLC, and NAC.

2. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.
3. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition, which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.
4. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.
5. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.
6. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.
7. Electrical supervision for circuits used for supervisory signal services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.
8. Confirmation or verification of all smoke detectors. The control panel shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices, other than smoke detectors, shall be programmed without confirmation or verification.
9. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided.
10. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.

11. The fire alarm control panel shall monitor and control the fire sprinkler system, or other fire protection extinguishing system.
12. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.
13. Zones for alarm IDC and SDC shall be arranged as indicated on the Contract Drawings.

C. Alarm Functions: An alarm condition on a circuit shall automatically initiate the following functions:

1. Transmission of signals over the station radio fire reporting system. The signals shall be as follows:
   a. General Alarm.
   b. Water Flow.
   c. Trouble.
2. Visual indications of the alarmed devices on the fire alarm control panel display and on the remote audible/visual display.
3. Continuous sounding or operation of alarm notification appliances throughout the building as required by ANSI S3.41.
4. Operation of the smoke control system.
5. Deactivation of the air handling units throughout the building.
6. Shutdown of power to the data processing equipment in the alarmed area.
7. Automatic discharge of the designated fire suppression systems. A 15-second maximum delay shall be provided for the deluge system, a 30-second delay for the wet pipe system.

D. Interface With Other Equipment: Interfacing components shall be furnished as required to connect to subsystems or devices which interact with the fire alarm system, such as supervisory or alarm contacts in suppression systems, operating interfaces for smoke control systems, door releases, etc.

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01300, SUBMITTALS:

1. Drawings:
   a. Fire Alarm Reporting System: Detail drawings, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the

Contract Drawings show layouts based on typical detectors. The CONTRACTOR shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

2. Statements:
   a. Testing: Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.
3. Reports:
   a. Testing: Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The CONTRACTOR shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.
4. Certificates:
   a. Equipment: Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.
   b. Qualifications: Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

1.5 DELIVERY AND STORAGE

A. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

PART 2 PRODUCTS

2.1 CONTROL COMPONENTS

A. Remote System Audible/Visual Display: Audible appliance shall have a minimum sound level output rating of 85 dBA at 10 feet and operate in conjunction with the panel integral display. The audible device shall be silenced by the system silence switch located at the remote location, but shall not extinguish the visual indicator. The remote LED/LCD visual display shall provide identification, consisting of the word description and ID number for each device as displayed on the control panel. A rigid plastic, phenolic or metal identification sign which reads "Fire Alarm System Remote Display" shall be provided at the remote audible/visual display. The remote visual appliance located with the audible appliance shall not be extinguished until the trouble or alarm has been cleared.

B. Circuit Connections: Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

C. Addressable Control Module: The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders. The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled.

D. Addressable Initiating Device Circuits Module: The initiating device being monitored shall be configured as a Style D initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling. The module shall be UL listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED.

E. Addressable Manual Fire Alarm Stations: Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on flush mounted outlet boxes. Manual stations shall be mounted at 48 inches. Stations shall be double action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the mounting surface.

F. Fire Detecting Devices: Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated.

G. Heat Detectors: Heat detectors shall be designed for detection of fire by fixed temperature. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

1. Fixed Temperature Detectors: Detectors shall be designed for semi-flush outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 135 degrees F. The UL 521 test rating for the fixed temperature detectors shall be rated for 15 by 15 ft.

H. Smoke Detectors: Smoke detectors shall be designed for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be

installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.

1. Photoelectric Detectors: Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.
2. Duct Detectors: Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph "Photoelectric Detectors," mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 6 feet and those mounted below 6 feet that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown functions specified in Section 15950, HVAC CONTROLS. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.2 NOTIFICATION APPLIANCES

A. Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red. Recessed audible appliances shall be installed with a grill that is painted red.

B. Combination Audible/Visual Notification Appliances: Combination audible/visual notification appliances shall provide the same requirements as individual units, except that they shall mount as a unit in standard backboxes. Units shall be factory assembled.

2.3 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

A. Conduit: Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242 and UL 797 and Division 16.

B. Wiring: Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The SLC wiring shall be copper cable in accordance with the manufacturers requirements. Wiring for Fire Alarm dc circuits shall be No. 14 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for Style 5 addressable systems.

PART 3 EXECUTION

3.1 INSTALLATION

A. All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

B. Wiring: Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any

component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

C. Control Panel: The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 12 inches nor more than 78 inches above the finished floor. Manually operable controls shall be between 36 and 42 inches above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

D. Detectors: Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the Drawings. Detectors shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided. Detectors installed in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD.

E. Notification Appliances: Notification appliances shall be mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.

F. Annunciator Equipment: Annunciator equipment shall be mounted where indicated on the Drawings.

G. Addressable Initiating Device Circuits Module: The initiating device circuits module shall be used to connect supervised conventional initiating devices (water flow switches, water pressure switches, manual fire alarm stations, high/low air pressure switches, and tamper switches). The module shall mount in an electrical box adjacent to or connected to the device it is monitoring and shall be capable of Style B supervised wiring to the initiating device. In order to maintain proper supervision, there shall be no T-taps allowed on Style B lines. Addressable initiating device circuits modules shall monitor only one initiating device each. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform supervisory and alarm functions as specified in Section 13930, FIRE SUPPRESSION SPRINKLER SYSTEM, as indicated on the Drawings and as specified herein.

H. Addressable Control Module: Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. If a supplementary suppression releasing panel is provided, then the monitor modules shall be mounted in a common enclosure adjacent to the suppression

releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices. All interconnecting wires shall be supervised unless an open circuit or short circuit abnormal condition does not affect the required operation of the fire alarm system. If control modules are used as interfaces to other systems, such as HVAC or elevator control, they shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits. Control modules that connect to devices shall supervise the notification appliance circuits. Control modules that connect to auxiliary systems or interface with other systems (non-life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform required alarm functions as specified in Section 13930, FIRE SUPPRESSION SPRINKLER SYSTEM, as indicated on the Drawings and as specified herein.

3.2 GROUNDING

A. Grounding shall be provided by connecting to building ground system.

3.3 TESTING

A. The CONTRACTOR shall notify the COTR/CM at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the COTR/CM. The control panel manufacturer's representative shall be present to supervise tests. The CONTRACTOR shall furnish instruments and personnel required for the tests.

B. Preliminary Tests: Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the CONTRACTOR shall complete and submit the NFPA 72, Certificate of Completion.

C. Acceptance Test: Acceptance testing shall not be performed until the CONTRACTOR has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The CONTRACTOR shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

1. Test of each function of the control panel.
2. Test of each circuit in both trouble and normal modes.
3. Tests of each alarm initiating devices in both normal and trouble conditions.
4. Tests of each control circuit and device.
5. Tests of each alarm notification appliance.
6. Complete operational tests under emergency power supply.
7. Visual inspection of wiring connections.
8. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
9. Ground fault.
10. Short circuit faults.
11. Stray voltage.
12. Loop resistance.

END OF SECTION

SECTION 16721
PREMISES COMMUNICATIONS DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Electronic Industries Association (EIA):
   a. EIA/TIA-568-A, Commercial Building Telecommunications Wiring Standard.
   b. EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
   c. EIA/TIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
   d. EIA/TIA-607, Commercial Building Ground and Bonding Requirements for Telecommunications.
   e. EIA TSB-67, Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling System.
2. Insulated Cable Engineers Association (ICEA):
   a. ANSI/ICEA S-80-576, Communication Wire and Cable for Wiring of Premises.
3. National Fire Protection Association (NFPA):
   a. NFPA 70, National Electrical Code.
4. Underwriters Laboratories, Inc. (UL):
   a. UL 444, Communications Cables.
   b. UL 467, Grounding and Bonding Equipment.
   c. UL 497, Safety Protector for Paired Conductor Communication Circuit.
5. Rural Electrification Engineers Association (REA):
   a. REA TE & CM 823, Electrical Protection of Gas Tuber Arrestors.

1.2 DEFINITIONS

A. Main Distribution Frame (MDF): An industry term that refers to a physical concentration or central location for termination backbone cables to interconnect with local exchange carrier (LEC) equipment at the activity minimum point of presence. The MDF generally includes vendor specific components to support voice, data, video, and public address circuits, building surge protector assemblies, main cross connect blocks, equipment support frames, and wood backboard (if MDF is wall mounted). Depending upon local site conditions, the MDF and BDF may be identical.

B. Building Distribution Frame (BDF): A structure with terminations for connecting backbone and horizontal cabling. The BDF generally includes a cross connect, patch panels, equipment support frame, and wooden backboard or terminal cabinet. The BDF shall include building protector assemblies.

C. Intermediate Distribution Frame (IDF): An industry term for intermediate termination points for horizontal wiring and cross connections within telecommunications closets or wiring closets.

D. Telecommunications Closet: An enclosed space for telecommunications equipment, terminations, and cross connect wiring for horizontal cabling.

1.3 SYSTEM DESCRIPTION

A. This specification is based on a original Premises Communication Distribution system specification for the Flight Simulator Building. It is intended to establish provisions and guidelines for the Contractor to add the necessary equipment and operational functions to the existing system. There may be equipment specified herein which may not be required for this addition. The Contractor shall coordinate the new and existing equipment requirements for the Flight Training Unit addition with the drawings for a complete and operable system.

B. The premises distribution system shall consist of inside-plant horizontal, riser, and backbone cables and connecting hardware to transport telephone and data (including LAN) signals between equipment items in a building.

C. There will be the 126th ARW data network in this building.

D. Both Voice and Data networks will adhere to the EIT/TIA 568-A and EIT/TIA 569 CAT 5E requirements.

1.4 QUALIFICATIONS

A. Minimum CONTRACTOR Qualifications:

1. All work under this section shall be performed by and all equipment shall be furnished and installed by a certified telecommunications contractor, hereafter referred to as the CONTRACTOR. With the exception of furnishing and installing conduit, electrical boxes, and pullwires, this work shall not be done by the electrical contractor. The CONTRACTOR shall have the following qualifications in Telecommunications Systems installation:
2. CONTRACTOR to lay out the completed system with a Registered Communication Distribution Designer (RCDD).

3. CONTRACTOR shall have a minimum of 3 years experience in the application, installation and testing of the specified systems and equipment.
4. All supervisors and installers assigned to the installation of this system or any of its components shall have factory certification from each equipment manufacturer that they are qualified to install and test the provided products. General electrical trade staff (electricians) shall not be used for the installation of the premises distribution system cables and associated hardware.
5. All installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper cable and components.

1.5 MINIMUM MANUFACTURER QUALIFICATIONS

A. The equipment and hardware provided under this contract will be from manufacturers that have a minimum of 3 years experience in producing the types of systems and equipment specified.

1.6 SUBMITTALS

A. Detail drawings including a complete list of equipment and material. The Drawings shall contain complete wiring and schematic diagrams and other details required to demonstrate that the system has been coordinated and will function properly as a system. Drawings shall include vertical riser diagrams, equipment rack details, elevation drawings of telecommunications closet walls, outlet face plate details for all outlet configurations, sizes and types of all cables, conduits, and cable trays. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. System drawings and records showing final configuration, including location, type, block, panel and terminal assignment of cabling in accordance with EIA 606.

B. Test plan defining the tests required to ensure that the system meets technical, operational and performance specifications, 60 days prior to the proposed test date. The test plan must be approved before the start of any testing and shall include testing milestones. The test plan shall identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

C. Test reports in booklet form with witness signatures verifying execution of tests. Test results will also be provided on (3-1/2-inch) diskettes in ASCII format. Reports shall show the field tests performed to verify compliance with

the specified performance criteria. Test reports shall include record of the physical parameters verified during testing. Test reports shall be submitted within 14 days after completion of testing.

D. Written certification by an RCDD that the premises distribution system fully complies with the EIA/TIA 568-A, EIA/TIA 569, EIA/TIA 606 and EIA 607 standards.

E. Provide certificates for Installers and RCDD.

1.7 RECORD KEEPING AND DOCUMENTATION

A. Cables: A record of all installed cable shall be provided on electronic media using Windows based computer cable management software per EIA ANSI/TIA/EIA-606. A licensed copy of the cable management software including documentation shall be provided. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility per EIA ANSI/TIA/EIA-606.

B. Termination Hardware: A record of all installed patch panels and outlets shall be provided on electronic media using Windows based computer cable management software] per EIA ANSI/TIA/EIA-606. A licensed copy of the cable management software including documentation shall be provided. The hardware records shall include only the required data fields per EIA ANSI/TIA/EIA-606.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70. It shall be compatible with material and equipment used elsewhere in the 126th ARW system.

2.2 UNSHIELDED TWISTED PAIR CABLE SYSTEM

A. Cable Insulation: For each individual Category 5E cable, the insulation, material used on each pair shall be exactly the same in all physical, electrical, and chemical respects. The use of Teflon insulated, plenum rated Category 5E cable is acceptable for both plenum and non-plenum applications. If Teflon insulated plenum rated cable is used by the CONTRACTOR, it shall be

Type 4x0, where all four pairs are Teflon insulated. Type 3x1 and 2x2 are not acceptable.

B. Riser and Horizontal Cable: Riser and Horizontal cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A for Category 5E horizontal cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Conductors shall be solid untinned copper 24 AWG. Cable shall be rated CMP per NFPA 70.

C. Use velcro wraps in lieu of plastic cable ties.

D. Connecting Hardware: Connecting and cross-connecting hardware shall be the same category as the cable it serves. Hardware shall be in accordance with cable and EIA ANSI/TIA/EIA-568-A.

1. Telecommunication voice/data outlets shall come equipped with four modular jacks. Two WHITE RJ-45 jacks labeled “voice,” two BLUE RJ-45 jacks labeled ANG DATA, and four blank. Four, 4-pair Category 5E cables will feed the outlet. Two white, 4-pair cables will feed two RJ-45 jacks. Two blue, 4-pair cables will feed ANG data terminals. Terminations will be in accordance with ANSE/TIA/EIA/568-A.
2. Patch Panels shall consist of eight-position modular jacks, with rear mounted Panduit CJ 588B, arranged in rows or columns on wall mounted panels. Jack pin/pair configuration shall be T568B per EIA ANSI/TIA/EIA-568-A. Panels shall be labeled with alphanumeric x-y coordinates.
3. Patch Cords for all positions shall be cable assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Patch cords shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring per EIA ANSI/TIA/EIA-568-A. Patch cords shall be factory assembled.

2.3 FIBER OPTIC CABLE SYSTEM

A. Multimode fiber optic cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A and ICEA S-83-596 for 62.5/125 micrometer multimode graded index optical fiber cable. Numerical aperture for each fiber shall be a minimum of 0.275. Cable construction shall be tight buffered type. Individual fibers shall be color coded for identification. Cable shall be imprinted with fiber count and aggregate length at regular intervals. Cable shall be rated OFNG per NFPA 70.

B. Connecting Hardware:

1. Connectors shall be ST type with ceramic ferrule material with a maximum insertion loss of .5 dB for use with multi-mode cables and SC type for single mode cables. connectors shall meet performance requirements of EIA ANSI/TIA/EIA-568-A. Connectors shall be field installable. Connectors shall utilize adhesive for fiber attachment to ferrule. Connectors shall terminate fiber sizes as required for the service.
2. Patch Panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Patch panels shall be for wall mounting. Patch panels shall provide strain relief for cables. Panels shall be labeled with alphanumeric x-y coordinates. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the 126th ARW system.
3. Patch cords for all fibers (36) shall be cable assemblies consisting of flexible optical fiber cable with connectors of the same type as used elsewhere in the system. Optical fiber shall be the same type as used elsewhere in the system. Patch cords shall be complete assemblies from manufacturer's standard product lines.

2.4 FIBER OPTIC HUBS

A. Provide two fiber optic 10/100BaseT Hubs for input multi-mode fiber and 24 ports each of RJ-45 Cat 5E LAN outlets. Provide hubs as manufactured by 3Com or equal as follows; two dual speed Superstacker II HUB 500, 24 port, including distance extender module, 100Base-FX, and cascade cable to match.

1. Dimensions and Weight:
   Dual Speed Hub 500
   Height: 44 mm (1U or 1.7 in)
   Width: 440 mm (17.3 in)
   Depth: 310 mm (12.2 in)
   Weight:
   24-port—2.7 kg (5.8 lb)
2. Mounting:
   Includes hardware for mounting in a standard 19-inch rack.
3. Connections and Cables:
   24 RJ-45 ports supporting 10BASE-T transmission over two pairs of Category 3, 4, or 5 UTP cable, or 100BASE-TX transmission over two pairs of Category 5 UTP/STP cable
4. Power Requirement:
   Dual Speed Hub 500
   Power Inlet: I C 320
   AC Line Frequency: 40 to 63 Hz

Input Voltage Options: 80 to 264
VAC RMS
Fuse Protection: 5 A

5. Power consumption:
Dual Speed Hub 500
24-port: 49 W
   a. Indicators
      Per Unit LEDs: Power status
      management/attention
      Per Segment LEDs:
      Collision/activity
      Per Port LEDs: Partition, status
   b. Standards Compliance
      IEEE 802.3µ 100BAS -T compliant
      IEEE 802.3µ 10BAS -T compliant
      Dual Speed Hub 500: 100 Mbps
      baseband CSMA/CD standard
      (complies with IEEE standard Class II repeater)*
      *The Dual Speed Hub 500 achieves this only as a stand-alone product, not as part of a stack.
   c. Functional
      ISO/I C 8802-3
      IEEE 802.3 (Ethernet)
      IEEE 802.3u (Fast Ethernet)
      IEEE 802.1D (Bridging)
      Safety
      UL 1950
      CSA-C22.2 No. 950
      EN 60950
   d. Electromagnetic Compatibility
      Dual Speed Hub 500
      EN 55022 Class A
      FCC Part 15 Class A
      VCCI Class 2
      EN 50082-1
      ICE -003 Class A;
      As in 2S 3548
6. Network Management Stand:
   a. Protocols

SNMP	RFC 1157
ARP	RFC 826
IP	RFC 791
ICMP	RFC 792
UDP	RFC 768

TCP	RFC 793
TFTP	RFC 783
SLIP	RFC 1055

b. MIBs

MIB II	RFC 1213
MAU	RFC 1515
RS 232	RFC 1659
RMON	RFC 1757
RMON-2	RFC 2021
Repeater	RFC 2108

7. Switch Performance:
   Dual Speed Hub 500
   4 K maximum addresses
   Learning rate: 50 addresses/second maximum
   Aging period default: 5 days
   Filtering: 163,680 frames/second
   Forwarding:
   10 Mbps—›100 Mbps: 14,880 frames/second
   100 Mbps—›10 Mbps: 14,800 frames/second
   Latency (store and forward only):‹—<=40 µS

PART 3 EXECUTION

3.1 INSTALLATION

A. System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions, RCDD design, and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with EIA ANSI/TIA/EIA-606. Penetrations in fire-rated construction shall be firestopped in accordance with Section FIRESTOPPING. Conduits, outlets and raceways shall be installed in accordance with Division 16 ELECTRICAL and EIA/TIA-569A. Wiring shall be installed in accordance with EIA ANSI/TIA/EIA-568-A. Wiring, and terminal blocks and outlets shall be marked in accordance with EIA ANSI/TIA/EIA-606. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation. Use velcro straps as necessary in lieu of plastic tie wraps. Velcro shall not cinch or kink cable bundles.

B. Horizontal Distribution Cable:

1. The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Copper cable not in a wireway shall be suspended a minimum 8 inches above ceilings by cable supports no greater than 60 inches apart. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided. A minimum separation of 12 inches shall be maintained. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Velcro straps shall not be excessively tightened such that the transmission characteristics of the cable are altered.
2. Faceplates: As a minimum each jack shall be labeled as to its function and a unique number provided by the 126th to identify cable link.
3. Cables: Unshielded twisted pair shall have a minimum of 6 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.
4. Terminal blocks shall be mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Industry standard wire routing guides shall be utilized. Wire routing guides similar and compatible with material used in the 126th system.
5. Unshielded Twisted Pair Patch Panels: Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 percent spares. Cable guides shall be provided above, below and between each panel.
6. Fiber Optic Panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant. A slack loop of fiber shall be provided within each panel. Loop shall be 3 feet in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.
7. Equipment Racks: Cable guides shall be bolted or screwed to racks. Racks shall be installed level. Ganged racks shall be bolted together. Ganged rack cabinets shall have adjacent side panels removed.
8. Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.

C. Termination:

1. Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles. Manufacturer's minimum bending radius shall not be exceeded.
2. Unshielded Twisted Pair Cable: Each pair shall be terminated on appropriate outlets, terminal blocks or patch panels. No cable shall be unterminated or contain unterminated elements. Pairs shall remain twisted together to within the proper distance from the termination as specified in EIA ANSI/TIA/EIA-568-A. Conductors shall not be damaged when removing insulation. Wire insulation shall not be damaged when removing outer jacket.
3. Fiber Optic Cable: Each fiber shall have connectors installed. The pull strength between the connector and the attached fiber shall be not less than 25 pounds. The mated pair loss, without rotational optimization, shall not exceed 1.0 dB. Fiber optic connectors shall be installed per EIA ANSI/TIA/EIA-568-A.
4. Grounding: Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with EIA ANSI/TIA/EIA-607 and Division 16 ELECTRICAL. Equipment racks shall be connected to the electrical safety ground.

D. Additional Materials:

1. The CONTRACTOR shall provide the following additional materials required for facility startup:
   a. 10 of each type outlet, including all parts necessary to build up an outlet.
   b. 10 of each type blank cover plate.
   c. 1 of each type terminal block (110 type, 100 pair) for each telecommunications closet.
   d. 4 patch cords of 10 feet for each telecommunications closet.
   e. 1 set of any and all special tools required to establish a cross connect and to change and/or maintain a terminal block.

3.2 ADMINISTRATION AND LABELING

A. Labeling:

1. All system components, i.e., outlets, terminal blocks, patch panels, cables, etc., shall be labeled in accordance with EIA ANSI/ TIA/EIA-606.
2. All cables will be labeled using labels on both ends with encoded identifiers per EIA ANSI/TIA/EIA-606.

3. Termination Hardware: All workstation outlets and patch panel connections will be labeled using labels with encoded identifiers per EIA ANSI/TIA/EIA-606.

3.3 TESTING

A. Materials, products, workmanship, and documentation to be furnished under this specification are subject to inspections and tests. All voice and data circuits shall be tested, and their components terminated prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

1. Unshielded Twisted Pair Tests: All metallic cable pairs shall be tested for proper identification and continuity. All opens, shorts, crosses, grounds, and reversals shall be corrected. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room. Backbone wiring shall be tested end-to-end, including termination devices, from terminal block to terminal block, in the respective communications closets. These test shall be completed and all errors corrected before any other tests are started.
2. Category 5E: All voice and data circuits shall be tested. Circuits shall be tested using a test set that meets the Class II accuracy requirements of EIA TSB 67 standard. Testing shall use the Basic Link Test procedure of EIA TSB 67. Cables which contain failed circuits shall be replaced and retested to verify the standard is met.
3. Fiber Optic Cable: Unless stated otherwise, tests shall be performed from HQ Building to Flight Simulator Building. Connectors shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist. Each circuit leg and complete circuit shall be tested for insertion loss at 1310 and 1550 nm using a light source similar to that used for the intended communications equipment. High-resolution optical time domain reflectometer (OTDR) tests shall be performed from one end of each fiber. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80 percent of the X-axis.

3.4 FIELD QUALITY CONTROL

A. In accordance with Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16722
SPEAKER SYSTEM EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes equipment for distributing and reproducing sound signals.

1.3 SUBMITTALS

A. Product Data: For each type of equipment.

B. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.

C. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.

D. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 70.

C. Comply with UL 50.

PART 2 PRODUCTS

2.1 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. Alpha Communications.
2. Atlas-Soundolier; Atapco Security & Communications Group.
3. Bogen Communications, Inc.
4. Executone Information Systems Inc.
5. Federal Signal Corp.; Signal Div./Electrical Products.
6. Or equal.

2.2 EQUIPMENT

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

2.3 PREAMPLIFIERS

A. Supplied and installed by others.

2.4 POWER AMPLIFIERS

A. Supplied and installed by others.

2.5 COMPONENTS

A. Telephone Paging Adapter: Supplied and installed by others.

B. Cone-Type Loudspeakers: Comply with EIA SE-103.

1. Minimum Axial Sensitivity: EIA pressure rating of 45 dB.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
4. Minimum Dispersion Angle: 100 degrees.
5. Rated Output Level: 10 W.

6. Matching Transformer: Comply with EIA-160. Full-power rated with four EIA standard taps. Maximum insertion loss of 0.5 dB.
7. Trans. Volts: 70.7/25 volt.
8. Volume Control: Supply with integral volume control when indicated on Drawings.
9. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.
10. Flush-Ceiling Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with baked, white-enamel finish. Mounting hardware as required.

C. Horn-Type Loudspeakers: Comply with EIA SE-103:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Comply with EIA-160. Full-power rated with four EIA standard taps. Maximum insertion loss of 0.5 dB.
3. Trans Volts: 70.7/25V.
4. Volume Control: Provide integral volume control on all units.
5. Exterior Use: Provide weather proof speaker and enclosure for all speakers inside and outside.
6. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
7. Dispersion Angle: 130 by 110 degrees.
8. Mounting: Integral bracket.
9. Units in Hazardous (Classified) Locations: Listed and labeled for the environment in which they are located.

D. Cable and Conductors: Jacketed, twisted-pair and twisted-multipair, untinned, solid-copper conductors.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 –inch thick.
2. Plenum Cable: Listed and labeled for plenum installation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment to comply with manufacturer's written instructions.

B. Wiring Method: Install wiring in raceway except within cable tray. Use plenum cable in environmental air spaces, including plenum ceilings.

C. Install exposed cables in conduit installed parallel and perpendicular to surfaces or exposed structural members, and follow surface contours.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

E. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.

G. Enclosures: Install all speakers using enclosure and grills compatible with surrounding ceiling/wall materials.

H. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than size shown on Drawings.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Division 16, Section 16450, GROUNDING.

3.3 FIELD QUALITY CONTROL

A. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Division 16, Section 16450, GROUNDING.

B. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare written record tests.

END OF SECTION

SECTION 16950
ELECTRICAL TESTING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. C2, National Electrical Safety Code.
   b. C37.20.3, Metal-Enclosed Interrupter Switchgear.
   c. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.
2. American Society for Testing and Materials (ASTM):
   a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
   b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.
   d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   e. D971, Standard Test Method for Interfacial Tension of 0.1 Against Water by the Ring Method.
   f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   h. D1500, Standard Test Method for ASTM Color of Petroleum Products.
   i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   j. D1533, Standard Test Methods for Water in Insulating Liquids.
   k. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
   l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop-Weight Method.
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.

b. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
c. 118, Standard Test Code for Resistance Measurement.
d. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

4. National Electrical Manufacturers Association (NEMA):
   a. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.2 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.
2. List of references to be used for each test.
3. Sample copy of equipment and materials inspection form(s).
4. Sample copy of individual device test form.

B. Quality Control Submittals: Submit within 30 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

C. Contract Closeout Submittals:

1. Operation and Maintenance Data: After test or inspection reports and certificates have been reviewed by COTR/CM and returned, insert a copy of each in operation and maintenance manual.

1.3 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.

4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories or a full Member Company of International Electrical Testing Association.

B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.4 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with COTR/CM prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify COTR/CM at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.

4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

B. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

C. Adjust mechanisms and moving parts for free mechanical movement.

D. Adjust circuit breakers and sensors to correspond to operating conditions, or as recommended by manufacturer.

E. Verify nameplate data for conformance to Contract Documents.

F. Realign equipment not properly aligned and correct unlevelness.

G. Properly anchor electrical equipment found to be inadequately anchored.

H. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

I. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

J. Provide proper lubrication of applicable moving parts.

K. Inform COTR/CM of working clearances not in accordance with NFPA 70.

L. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

M. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by COTR/CM, door and panel sections having dented surfaces.
5. Repair or replace, as determined by COTR/CM, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.

8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required due to extensive damage, as determined by COTR/CM, refinish the entire assembly.

N. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

O. Replace transformer insulating oil not in compliance with ASTM D923.

3.2 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. 10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 7.2.4.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for any fans, controls, and alarm functions as suggested by manufacturer.

3.3 LIQUID FILLED TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Effective core and equipment grounding.
6. Removal of shipping brackets, fixtures, or bracing.
7. Tank leaks and proper liquid level.
8. Integrity and contamination of bus insulation system.
9. Verify that tap-changer is set at correct ratio for rated voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. 10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS Table, 7.2.4.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.
3. Sample Insulating Oil in Accordance with ASTM D923 and Have Laboratory Tested For:
   a. Dielectric breakdown voltage in accordance with ASTM D877 or D1816.
   b. Acid neutralization number in accordance with ASTM D974 and D665.
   c. Interfacial tension in accordance with ASTM D971 or D2285.
   d. Color in accordance with ASTM D1500.
   e. Visual condition in accordance with ASTM D1524.
   f. Specific gravity in accordance with ASTM D1298.

g. Water content, in parts per million, in accordance with ASTM D1533.
h. Dielectric fluid test results in accordance with NETA ATS, Table 7.2.2.
i. Power factor at 25 degrees C and at 100 degrees, in accordance with ASTM D924.
j. Maximum power factor, corrected to 20 decrees C, in accordance with manufacturer's specifications.

3.4 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 4/0 and Larger For:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specifications.
   e. Proper circuit identification.
2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
3. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.
4. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 4/0 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

3.5 MEDIUM VOLTAGE CABLES, 15 KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Cable For:
   a. Physical damage plus jacket and insulation condition.
   b. Proper connections in accordance with single-line diagram.
   c. Proper shield grounding.
   d. Proper cable support.
   e. Proper cable termination.
   f. Cable bends not in conformance with manufacturer's minimum allowable bending radius.
   g. Proper arc and fireproofing in common cable areas.
   h. Proper circuit and phase identification.
2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturers.

B. Electrical Tests:

1. Shield Continuity Tests:
   a. By ohmmeter method on each section of conductor.
   b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.
2. High Potential dc Tests:
   a. In accordance with NEMA WC 8 for EPR insulated conductors.
   b. Each conductor section tested with:
      1) Splices and terminations in-place but disconnected from equipment.
      2) Remaining conductors and shields grounded in accordance with IEEE 400.
   c. Apply maximum dc test voltage of 65 kV for 15 kV, 133 percent insulation conductor.
   d. Measure only the leakage current associated with conductor.
   e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.
   f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48 or manufacturer's specifications.
   g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.
      1) Increments not to exceed ac voltage rating of conductor.
      2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.

h. Raise conductor to specified maximum test voltage and hold for 15 minutes, or as specified by conductor manufacturer. Record dc leakage current at 30 seconds and 1 minute and at 1-minute intervals, thereafter.
i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.
j. Test results evaluated on a pass/fail basis.

3.6 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Proper phase barrier material and installation.
7. Verify that fuse sizes and types correspond to one-line diagram.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.7 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.

4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

3.8 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to Contract Documents.
4. Check calibration of meters at all cardinal points.
5. Check calibration of electrical transducers.

3.9 COPPER COMMUNICATIONS CABLE

A. Testing of communication cables shall be done with all conductors pulled and terminated on their respective distribution frames, and all splicing and closures in place.

B. The following acceptance tests shall be performed in accordance with REA PC-4:

1. Shield continuity.
2. Conductor continuity.
3. Conductor insulation resistance.
4. Structural return loss.
5. Cable insertion loss and loss margin at carrier frequencies.
6. Shield ground for single jacketed cables.
7. DC loop resistance.

3.10 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in switchgear assemblies for proper connection and tightness.
2. Ground bus connections in switchgear assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-Of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   b. Resistance to ground of any grounding electrode to be no greater than 5 ohms.
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.25 ohm.

END OF SECTION